CHAPTER 4: ACOUSTIC DOPPLER CURRENT PROFILER HARDWARE AND ANCILLARY EQUIPMENT

In this chapter we discuss the equipment needed to measure river discharge with an ADCP (fig. 4.1). Although a generic discussion of ADCPs is provided in this report, the following three sections cover the ADCP manufactured by RDI. The reason for this is twofold:

- Until recently, RDI was the only manufacturer of ADCP systems that could be utilized for discharge measurements (bottom-track algorithms). Another vendor (Sontek) has developed a bottom-tracking ADCP that can be used for discharge measurements, but the system is not yet widely used by the USGS

- As discussed in chapter 2, RDI has written discharge-measurement software that is integrated with the ADCP to calculate discharge and to store data (Transect software). Knowledge of the details of this software is required for the collection of accurate discharge measurements.

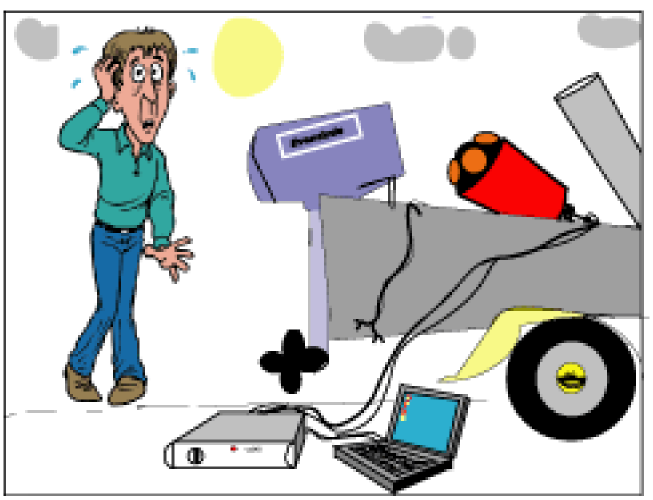

Figure 4.1. “Which equipment do we need?”

When another ADCP manufacturer produces a capable system that is used by a significant number of USGS offices, a description of that system (and its associated software) will be included in a follow up to this report.

Where Do We Start?

The following equipment is needed to measure river discharge with an ADCP:

<u>ADCP system</u>

- Pressure case and transducer assembly
- Power supply and communications interface
- Discharge-measurement software
- Manufacturer’s documentation

<u>Ancillary equipment</u>

- Measurement platform or vessel
- ADCP mounting assembly
- Laptop computer
- Range finder or method for estimating distance to shore

Of course, the measurement equipment is worthless unless used by a competent, well-trained ADCP operator. If a boat is used, the skipper must be experienced in boat-maneuvering techniques required for ADCP discharge measurement and must have attended a U.S. Department of Interior (DOI) boat safety course.

Acoustic Doppler Current Profiler Equipment

Acoustic Doppler Current Profiler Pressure Case and Transducer Assembly

The direct-reading BB-ADCP is configured much like the narrow-band ADCP (Simpson and Oltmann, 1993); however, the transducer and electronics are contained in the same cylindrical enclosure (pressure case). The diameter of the enclosure is approximately 150–220 millimeters (mm), depending on the configuration. A convex or concave transducer assembly on one end of the cylindrical canister employs an orthogonal (Janus) beam aiming

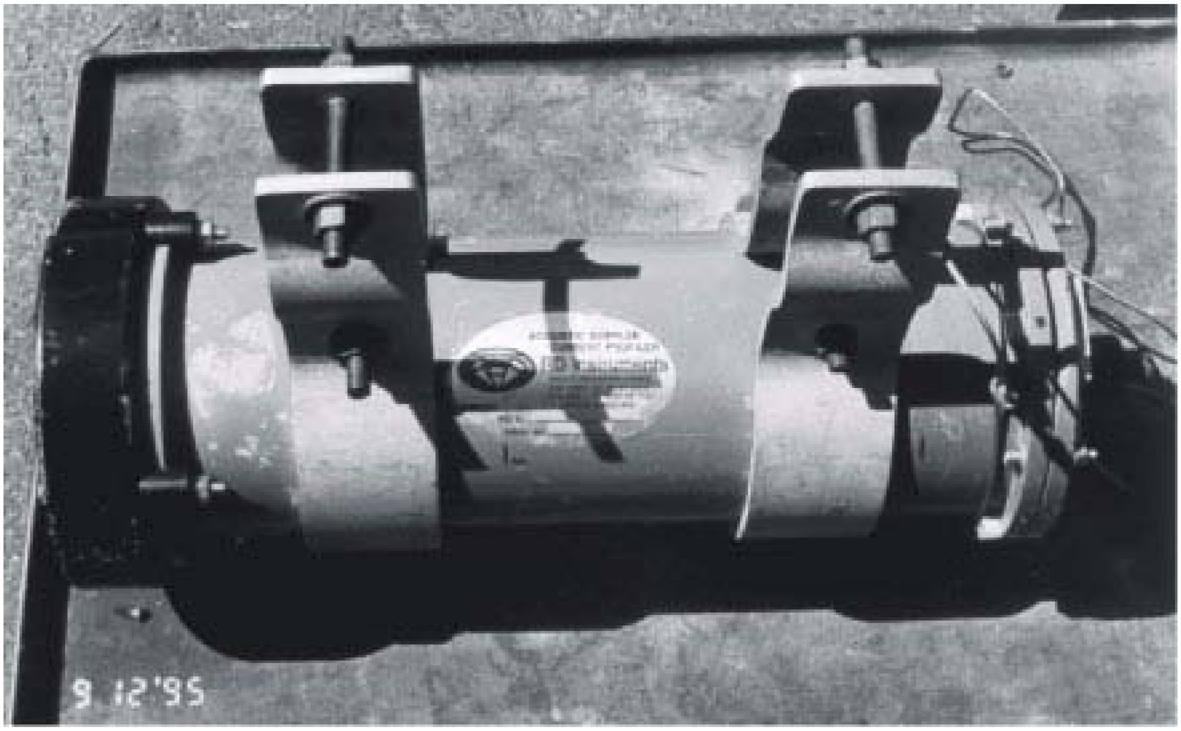

Figure 4.2. A 1,200-kilohertz broad-band acoustic Doppler current profiler with attached pipe brackets.

pattern with the three or four transducer beams angled 20º (or optionally 30º) outward from the center axis of the assembly. The transducer assembly diameter depends on the frequency of operation and configuration. For most work, the concave transducer head has proven to be more durable because it is protected somewhat from floating debris and direct contact with the river bottom. Figure 4.2 shows a BB-ADCP with a 1,200-kHz concave transducer assembly with pipe brackets attached.

RDI has introduced another version of the BB-ADCP into its product line called the "Workhorse." The Workhorse line of ADCPs can be purchased with or without bottom-tracking capability. A river version of the Workhorse (the Rio Grande, fig. 4.3) is available with bottom-tracking and operational modes suited to river-discharge measurements.

Power Supply and Communications Interface

For BB-ADCP direct-reading units, the manufacturer supplies a deck unit with the BB-ADCP that can convert several power sources to voltages required by the BB-ADCP. The deck unit can accept 120-volt (V) alternating current (AC), 20- to 60-volt

Figure 4.3. An R.D. Instruments, Inc., 600-kilohertz Workhorse "Rio Grande" acoustic Doppler current profiler.

direct current (DC), or 12-volt DC (fig. 4.4). The deck unit has a power switch on the front panel as well as two luminescent electronic display (LED) indicators. One LED indicator lights up when power is applied to the deck unit, and the other LED indicator lights up when data are being transmitted to and from the ADCP.

A 13-mm (0.5-inch) diameter cable connects the BB-ADCP to the deck unit assembly. At the ADCP end, the cable is potted to an underwater connector (fig. 4.5). The shell connector at the deck unit end of the cable has

Figure 4.4. Front and rear view of an R.D. Instruments, Inc., acoustic Doppler current profiler deck unit.

24 pins and uses a bayonet-style connector. The overhang on the back of the deck unit can hinder the ability to easily disengage this connector and many users do not fully engage the bayonet mechanism. Connectors for RS-232 serial communications, power connections, and fuse holders also are on the back panel of the deck unit. The fuses protect the ADCP and deck unit in the event of short circuits and incorrect (reverse) battery polarity.

The manufacturer also markets an ADCP product known as the “Workhorse Rio Grande” (fig. 4.3) that does not require a separate deck unit. The Workhorse is powered directly from a DC source, or optionally from a 120-volt AC to a 12-volt DC converter. The Workhorse communications cable and the power supply cable are attached to the pressure case by way of a submersible connector.

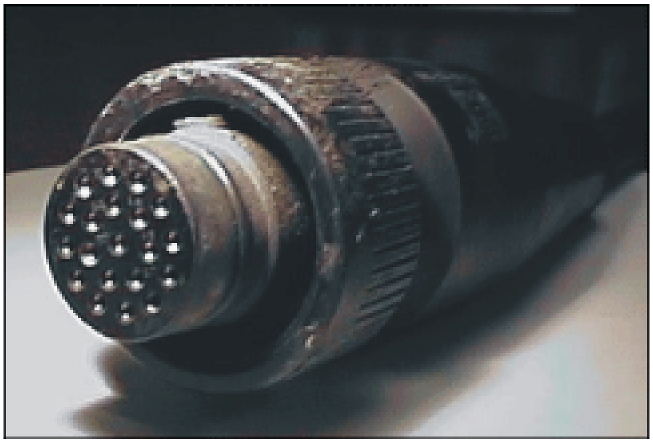

Figure 4.5. Connector cable for attachment of R.D. Instruments, Inc., broad-band acoustic Doppler current profiler to accompanying deck unit.

Acoustic Doppler Current Profiler Discharge-Measurement Software

To measure river discharge, the ADCP system is controlled by discharge-measurement software (chaps. 2, 3). The configuration of this software is discussed in detail in chapter 5.

Documentation

The manufacturer provides several pieces of documentation that are essential for the proper operation and setup of the BB-ADCP including "The Direct Reading and Self-Contained BB-ADCP Technical Manual" (R.D. Instruments, Inc., 1995). For those using the Workhorse Rio Grande, RDI provides "Workhorse Rio Grande Technical Manual P/N 957-6101-00," November 1999. Also needed is the Transect Program users manual for the broad-band acoustic Doppler current profilers (R.D. Instruments, Inc., 1994). The technical manual is shipped with each ADCP; however, the Transect computer software and manual must be purchased separately. The Transect software and users manual are shipped as computer diskettes. Both manuals are updated periodically and hard copies of these updates can be obtained from the manufacturer for a fee. The manufacturer also maintains an internet web site that provides downloadable copies of the latest ADCP documentation updates, technical bulletins, and complete manuals (www.rdinstruments.com). The operator also should become familiar with the "Quality assurance plan for discharge measurements using broad-band acoustic Doppler current profilers" (Lipscomb, 1995).

Ancillary Equipment

Measurement Platform or Vessel Requirements

Discharge measurement platform or vessel requirements will vary, depending on the size and flow rates of the rivers and streams. For example, if measurements are in large rivers or estuaries, the BB-ADCP may be mounted on a 9- to 15-m (30- to 50-foot) vessel with an enclosed cabin. If, on the other hand, discharge measurements are on small, slow-moving rivers, the vessel of choice may be a 5- to 6-m (16- to 20-foot) skiff. For very small streams or rivers with minimal wave action, the BB-ADCP may be mounted on an inflatable boat, such as a Zodiac.

For improved safety while taking measurements that would be hazardous using manned platforms or to avoid traffic hazards, the USGS Indiana District has developed a tethered platform (fig. 4.6). For flood work and bridge scour measurements, the USGS Office of Surface Water has developed a prototype radio-controlled platform (fig. 4.7).

Figure 4.6. Tethered acoustic Doppler current profiler discharge measurement platform.

Figure 4.7. Radio-controlled, 12-foot, broad-band acoustic Doppler current profiler platform.

The proper boat choice will depend on the topography and hydrology of the area of interest; however, it is best to have several alternative vessels for discharge measurement use. In the USGS California District, three boats are used for ADCP discharge measurements. Figure 4.8 shows a 30-m (95-foot) vessel with a side-swing mount. Using this configuration, measurements in the estuary can be obtained under all but the worst of conditions.

Figure 4.9 shows a similar mount on a 6-m (20-foot) Boston Whaler. This vessel can be used in estuaries, rivers, and in river tributaries. A large 150-horsepower (hp) engine is used to get from place to place quickly when making discharge measurements in an estuary or river delta. A smaller engine is used when making discharge measurements in small rivers and

Figure 4.8. Two views of an acoustic Doppler current profiler side-swing mount on a 30-meter (95-foot) vessel.

slow-moving water. This vessel can be rigged with canvas for inclement weather.

Figure 4.10 shows a side-swing mount on a 4.5-m (15-foot) Boston whaler. This vessel is easily trailerable and is used when measuring small rivers. The main engine has a four-cycle, 45-horsepower engine that can be idled at low speeds for discharge measurement. This configuration is used mainly in fair weather; however, canvass also can be rigged to make the vessel usable in inclement weather.

When making discharge measurements in narrow rivers, a trolling plate can be used on the main engine or an electric trolling motor can be used to slow the vessel. For accurate measurements in very slow-velocity water, this vessel can be pulled on a tagline.

In Sweden, BB-ADCP operators have used a small, inflatable dinghy when making discharge measurements (fig. 4.11). The advantage of this type of vessel is that launch ramps are not needed. The dinghy can be inflated on the riverbank and the equipment set up for use in less than 30 minutes.

It is imperative that not only the correct boat be used for any given set of river and weather conditions, but also that boat operators be properly trained. Correct

Figure 4.9. Side-swing mount on a 6-meter (20-foot) Boston Whaler for an acoustic Doppler current profiler.

operation of the boat is vital to obtaining high-quality discharge and velocity measurements. The DOI requires that boat operators attend a DOI motor boat operators training course before operating a USGS boat or vessel. All passengers on USGS vessels should wear life jackets (type V or better) and observe all U.S. Coast Guard and USGS water safety regulations.

Laptop Computer

The computer selection for running the BB-ADCP software is very important. Because of the amount of data processing required, the computer must have an i286 central processing unit (CPU) or equivalent (an i386, i486, or Pentium CPU is desirable), and also must be IBM compatible. The computer at least must be capable of displaying extended graphics array (EGA) compatible graphics. Because of the amount of data storage required, a hard drive (nonvolatile ram drive) should be used with at least 20 megabytes (Mb) of available storage space.

The computer screen display should be visible in direct and diffuse sunlight (fig. 4.12). Those computers that do not rely on backlighting for display illumination

Figure 4.10. Side-swing mount on a 4.5-meter (15-foot) Boston Whaler for an acoustic Doppler current profiler.

seem to have the most visible display in direct sunlight. Standard monochrome liquid crystal display (LCD) and LEDs have the best visibility. Active matrix color displays have fair-to-poor visibility, and dual scan color LCD displays have poor-to-no visibility in direct sunlight. The computer purchase should be based on the computer's ability to run the Transect software and on the visibility of the screen display in direct sunlight.

For routine collection of streamflow data, a rugged laptop computer is desirable. Several manufacturers now produce laptops with antiglare screen coatings, shock-mounted hard drives, and water-resistant keyboards and access panels. Standard laptops have minimal protection from the elements; rain and dust protection are not provided and many have flimsy plastic doors covering the port connections. These plastic doors fall off or are easily broken (fig. 4.13).

Do not rely on the internal laptop battery to provide power for an all-day measurement session because most laptop batteries will not last beyond about 3 hours and many will not last 1 hour before requiring recharge. Most of these rechargeable batteries tend to

Figure 4.11. Acoustic Doppler current profiler mount for an inflatable dinghy.

Figure 4.12. Laptop computer screen in diffuse sunlight.

gradually lose capacity with age. The measurement system operator should attempt to power the computer from an external battery with a large capacity, such as an external 12-volt automobile or deep-cycle marine battery. Many of the newer laptops do not directly accept 12-volt power and require special adapters for power conversion. These adapters should be purchased with the computer, if possible, because they may be unavailable with ensuing computer model changes. Most adapters have a cigarette lighter plug at the 12-volt end of the adaptor. The cigarette lighter plug can be replaced with two alligator clips that can be attached directly to battery terminals. Another alternative for laptop power is to purchase a 200-watt (W) inverter. There are several small efficient inverters on the market today that do not draw excessive power under idle conditions. The inverter is connected to the 12-volt batteries and the computer AC adaptor is plugged into the inverter.

The data-processing computer is connected to the BB-ADCP through a serial connection on the back of the deck unit. Normally, this serial connection is RS-232c; however, for long cables (longer than 200 ft), RS-422 protocol should be used. RS-422 protocol requires the use of a separate converter box as well as changes in the internal BB-ADCP switch settings (R.D. Instruments, Inc., 1995). The RS-232c serial connection is provided by way of a standard IBM personal computer (PC) 9-pin female to 25-pin male adaptor cable, which is available in most computer shops. A null-modem adaptor is not needed.

The computer must be protected from direct sunlight and heat during data collection. The LCD screen turns dark and unusable if it remains in direct sunlight too long. The computer also can be damaged by the heat of direct exposure to the sun. One solution is to place the computer inside an empty cooler that is turned on its side. The cooler shades the computer and

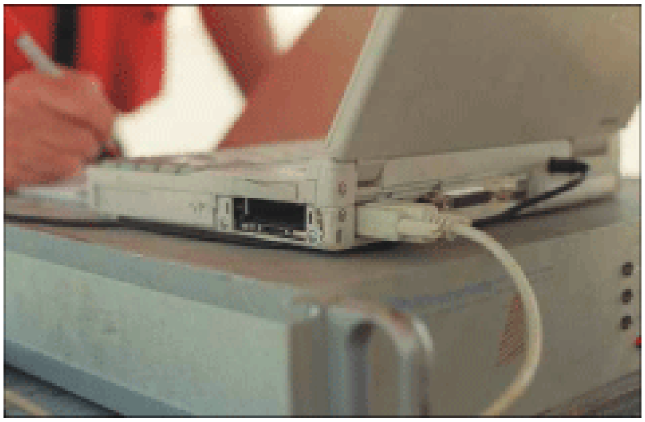

Figure 4.13. Laptop computer with missing plastic doors and port covers.

LCD from direct sunlight and also protects the computer from splashing water.

Acoustic Doppler Current Profiler Mounts

For discharge measurement or profiling, the BB-ADCP is positioned with the transducer assembly facing downward into the water column with beam three oriented forward. The BB-ADCP can be mounted in many different ways, but two methods have been used for most deployments; the side-swing mount and the “sea chest” mount.

Figures 4.14 and 4.15 show two types of side-swing mounts that have been used successfully. An inexpensive mount made from 51-mm (2-inch) aluminum pipe and 51-mm by 305-mm (2-inch by 12-inch) lumber is shown in fig. 4.14, and a more expensive mount fabricated from 6061-T aluminum is shown in fig. 4.15. These types of mounts have been used on boats that range in length from 4–30 m

Figure 4.14. Inexpensive acoustic Doppler current profiler mount.

(14–95 ft) and on streams 3.5 m (10 ft) wide and on rivers as wide as 1.6 km (1 mi). These mounts have the disadvantage of being far from the boat keel and, therefore, are subject to altitude changes caused by pitch and roll. However, for most applications, these mounts produce acceptable results.

Figure 4.16 shows a “sea-chest” mount that has been used successfully for narrow-band ADCPs and can be modified for use with BB-ADCPs. The “sea-chest” mount has the advantage of being close to the

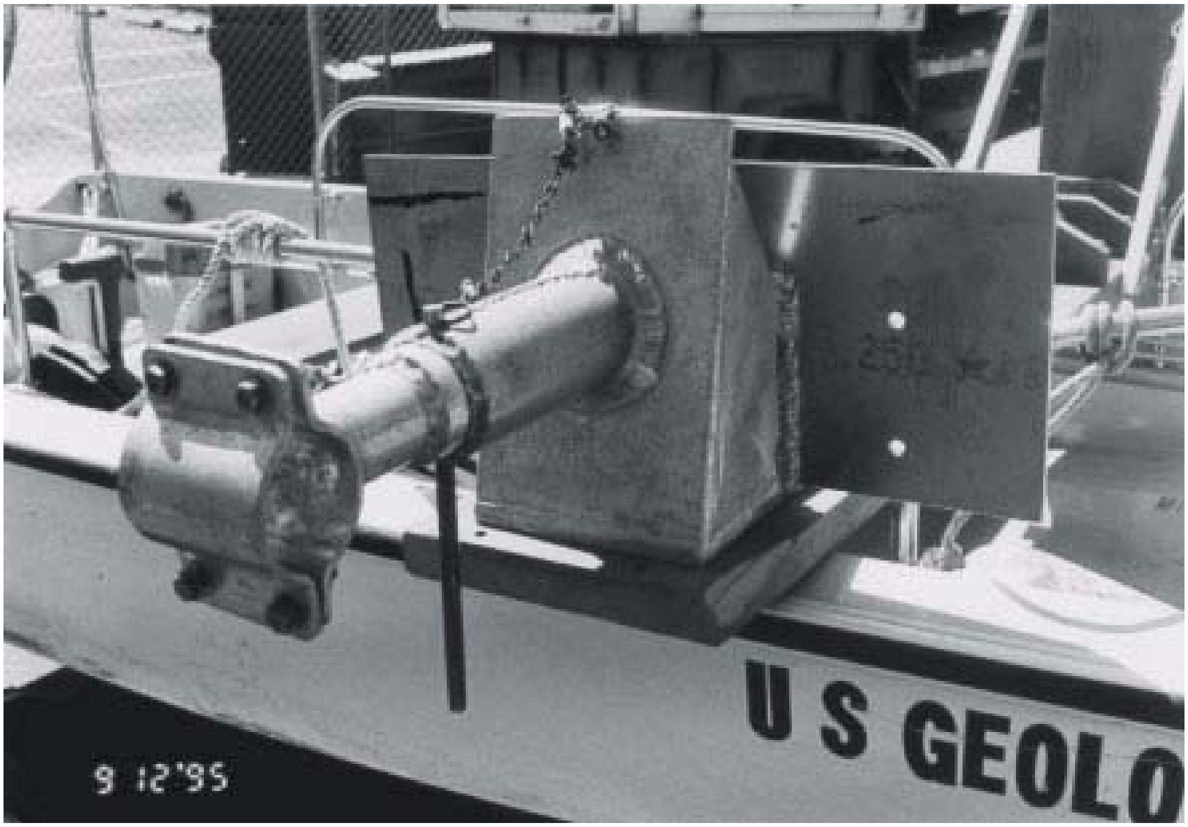

Figure 4.15. Aluminum acoustic Doppler current profiler mount.

boat keel and, therefore, less subject to altitude changes due to pitch and roll. The position also places the BB-ADCP away from edges of the boat wake where entrained air is present. Entrained air can cause loss of bottom track.

ADCP operators at Tampa, Florida, have developed a variant of the swing mount (fig. 4.17) that allows the BB-ADCP to be easily swung aboard the measurement vessel. A hydraulic mount was designed and installed on a “john boat” in the USGS Indiana District (fig. 4.18). A unique variant of the transom mount was designed by Harry Hitchcock of the USGS Kentucky District (fig. 4.19). An inboard variation on the transom swing mount is being used by the USGS Illinois District (fig. 4.20). An easily detachable swing mount was designed and used by the USGS Idaho District (fig. 4.21).

Range Finder or Method for Estimating Distance to Shore

Edge discharges are estimated in the Transect software using a technique similar to that used when making conventional discharge measurements. The unmeasured area between the boat and the river edge is estimated using the last measured mean velocity, the last measured depth, and the distance from the boat to shore. The algorithm assumes a triangular-shaped area

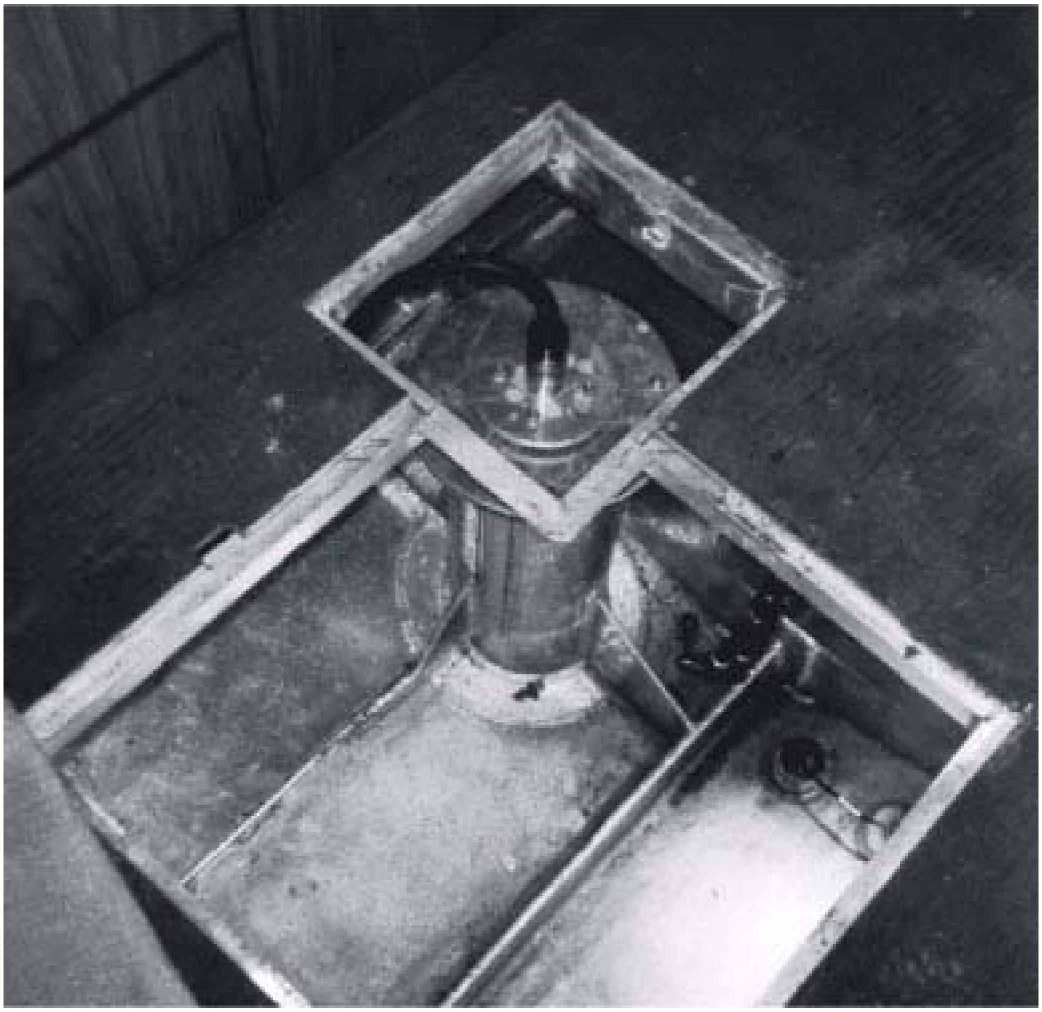

Figure 4.16. Sea-chest mount for a narrow-band acoustic Doppler current profiler.

for this estimate. If the river channel is rectangular, these edge estimates can be doubled and an adjustment made for the roughness of the edges.

Estimating the distance to shore can be done with the naked eye; however, such distance estimates are almost always short of the true distance (underestimated). The reason for this is unclear, but is possibly due to lack of visual clues between the boat and shore. The most reliable way of ensuring accurate edge estimates is to set buoys out from the shore at known distances (measured with a tape or distance meter). The Transect software is then started and stopped at these buoys. This method is not always possible when large numbers of discharge measurements are needed at different locations within a short time period.

Figure 4.17. Mount used by the U.S. Geological Survey Tampa, Florida, Subdistrict.

There are several types of distance-measurement devices on the market that have been used to increase the accuracy of the edge estimates without the need to set buoys or onshore devices. The devices can be placed into three categories:

- •Optical
- •Sonic
- •Infrared laser

Good results have been obtained with inexpensive, optical range finders (fig. 4.22) that use parallax and a focusing device to estimate distance. The operator identifies a rock or object at the stream edge and then rotates a knob to converge two images of the object. The distance is then read from a scale on the device. This method requires a little practice but, with properly calibrated range finders, acceptable accuracy can be obtained up to about 180 m (600 ft).

Sonic devices that have been tried, require a vertical wall for a signal return. Riverbank edges generally do not have topographies that enhance acoustic reflections. To be usable, these devices need special sonic targets (corner reflectors) placed on the riverbanks. These devices can be useful if the operator

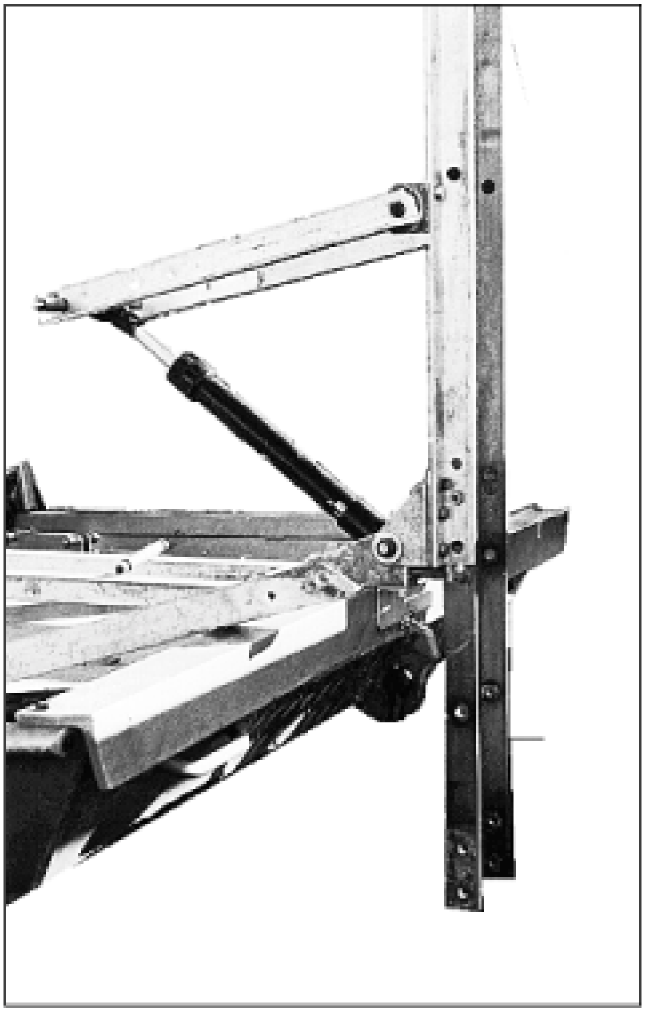

Figure 4.18. Hydraulic mount used by the U.S. Geological Survey Indiana District.

is able to deploy the sonic targets at the cross-section edges.

Laser devices are cumbersome and more delicate than the other range finders, but can be more accurate over longer distances. They can be used without targets (corner reflectors) up to about 75 m (250 ft) and up to hundreds of meters (thousands of feet) with targets. The major drawback to these devices are their cost and durability. They require precision optics, which are delicate and easily damaged.

Trolling Motors/Plates

Discharge measurements typically require the use of slow boat speeds, especially in low water-velocity conditions. The main boat engine usually is too large for use when making discharge measurements. A battery-operated trolling motor (fig. 4.23) with variable speeds or a small gasoline-driven marine engine may be used to maneuver the boat at the slow speeds required for making a discharge measurement.

If an electric trolling motor is used, extra deep-cycle marine batteries should be included in the discharge-measurement equipment inventory. When using a trolling motor, a full day of discharge measurements may require two or more fully charged, deep-cycle marine batteries. If a gasoline-powered trolling motor is used, the operator may wish to purchase a four-cycle marine engine. A four-cycle engine is quieter than a two-cycle engine, does not smoke as much, idles for longer times at low speeds without spark plug fouling, and does not require an oil/gas mixture for operation.

Inexpensive steering adapters (fig. 4.24) can link smaller trolling motors to the main engine steering, and remote throttles and gearshifts also can be console mounted. Electric trolling motor steering even can be done with a foot pedal.

Miscellaneous Measurement Equipment

Miscellaneous discharge-measurement equipment may include the following:

- Buoys with attached anchors for marking cross-section edges
- Tag-line systems for measuring very slow velocities

Figure 4.19. "Toggle" mount used by the U.S. Geological Survey Kentucky District.

- External depth sounders and navigation equipment
- Rain/sun canopy and computer-protection gear

Installation of the Broad-Band Acoustic Doppler Current Profiler

Mounting the Acoustic Doppler Current Profiler on the Vessel

The ADCP is mounted on the measurement vessel using the mounting systems described previously. In most cases, beam three is oriented toward the bow of the vessel, however, if the vessel will be measuring discharge next to bridge piers or vertical walls, the ADCP should be oriented such that the beams are at 45º angles to the axis of the vessel. This orientation allows the closest approach to the vertical wall.

Care must be taken to eliminate magnetic fields or ferrous materials from the vicinity of the pressure case. Not only the ADCP mounts, but all nuts, bolts, and other fasteners must be made from nonferrous materials.

Figure 4.20. Swing mount variation used by the U.S. Geological Survey Illinois District.

Deck-Unit and Power-Supply Connections

The other components of the BB-ADCP system also must be mounted or placed in safe (splash-free) areas on the measurement vessel. There are some precautions to be observed when installing the system components. The deck unit (if used) should be positioned out of direct sunlight (excessive heat) and away from exposure to moisture (the housing for the deck unit electronics is not waterproof). The deck unit should be opened and examined to ensure that all components (especially the DC-to-DC convertor block) are firmly attached to the board socket by some means other than electrical connector pins. The manufacturer has corrected this problem, but several of the early deck units had no mechanical attachments on the DC-to-DC converter block. The block would become dislodged during transportation and the deck unit would not function when connected to 12-volt DC power.

The connections on the back of the deck unit are shown in figure 4.25. Using the deck unit, the BB-ADCP may be powered with 110- to 120-volt AC power, 12-volt DC power, or 20- to 60-volt DC power. The AC power is supplied to the deck unit using a standard IBM personal computer-style pigtail

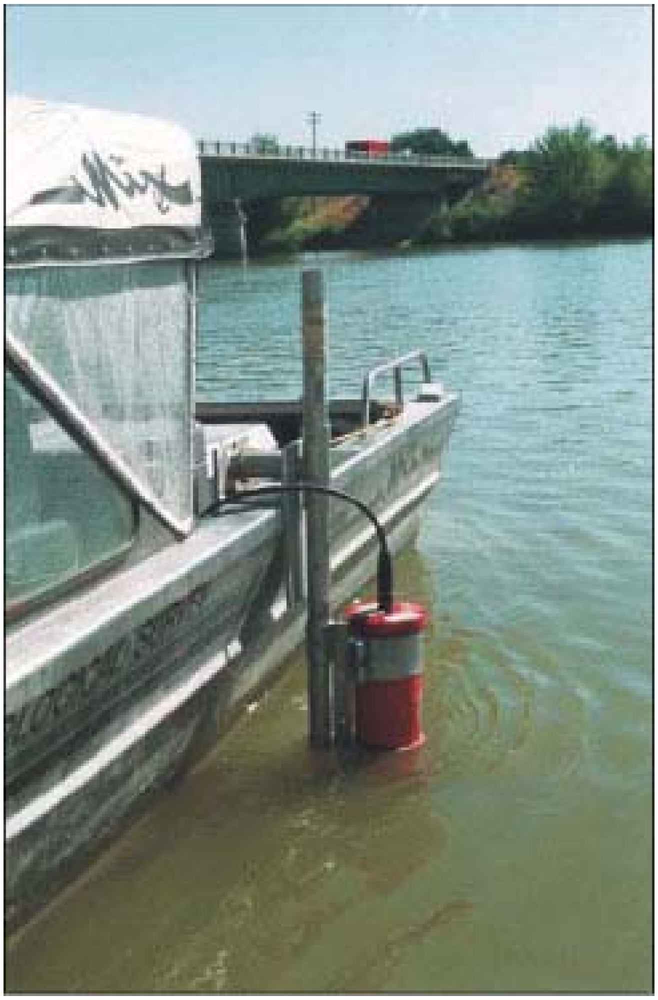

Figure 4.21. Detachable swing mount used by the U.S. Geological Survey Idaho District.

connection. The 12-volt DC power is supplied using a user-designed cable connected to the labeled terminal block on the back of the deck unit. Polarity is important when connecting to this terminal block using this cable connector. Early versions of the deck unit did not have input diode protection and could be damaged by improper DC polarity. The input polarity should be double checked before applying power. Most experienced BB-ADCP users begin a daily measuring session with two fully charged marine deep-cycle batteries. One fully charged 12-volt battery should

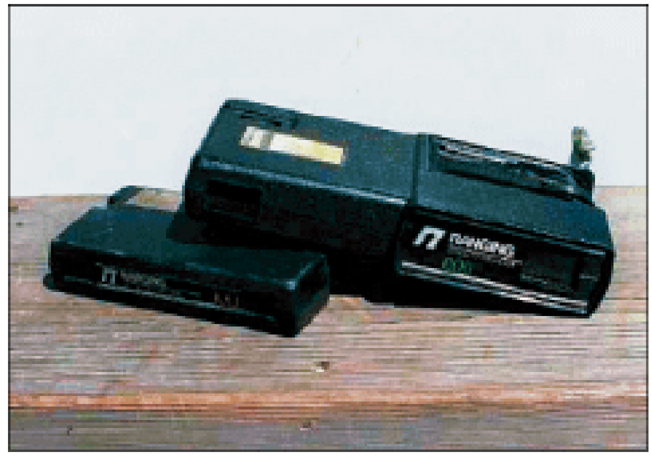

Figure 4.22. Optical range finders used to estimate near-shore distances.

power the BB-ADCP and computer for the whole day. The second battery is for backup.

A range of 20–60 V DC can be supplied to the deck unit through the bayonet style coaxial (BNC) connector (fig. 4.25). This voltage also must have proper polarity, as it is delivered directly to the BB-ADCP. The voltage must be supplied using a properly insulated (center positive) female BNC connector. IMPORTANT!!! These voltage magnitudes can be lethal, especially around water. Make sure all connections are insulated properly.

The voltage entering the 20- to 60-volt connector does not go through the DC-to-DC convertor before being sent to the BB-ADCP; therefore, it is not “stepped up” to the nominal BB-ADCP transmit voltage of 50. Voltages less than 30 may not supply the BB-ADCP with enough transmit power to enable profiling in the deeper depth ranges, especially if the water has few scatterers. Voltages greater than 60 may damage BB-ADCP power regulation components.

Acoustic Doppler Current Profiler Cables and Connectors

Broad-Band Acoustic Doppler Current Profiler

A multi-pin shell connector on the BB-ADCP cable connects to a 24-pin bayonet socket on the back of the deck unit. This connector assembly is not very

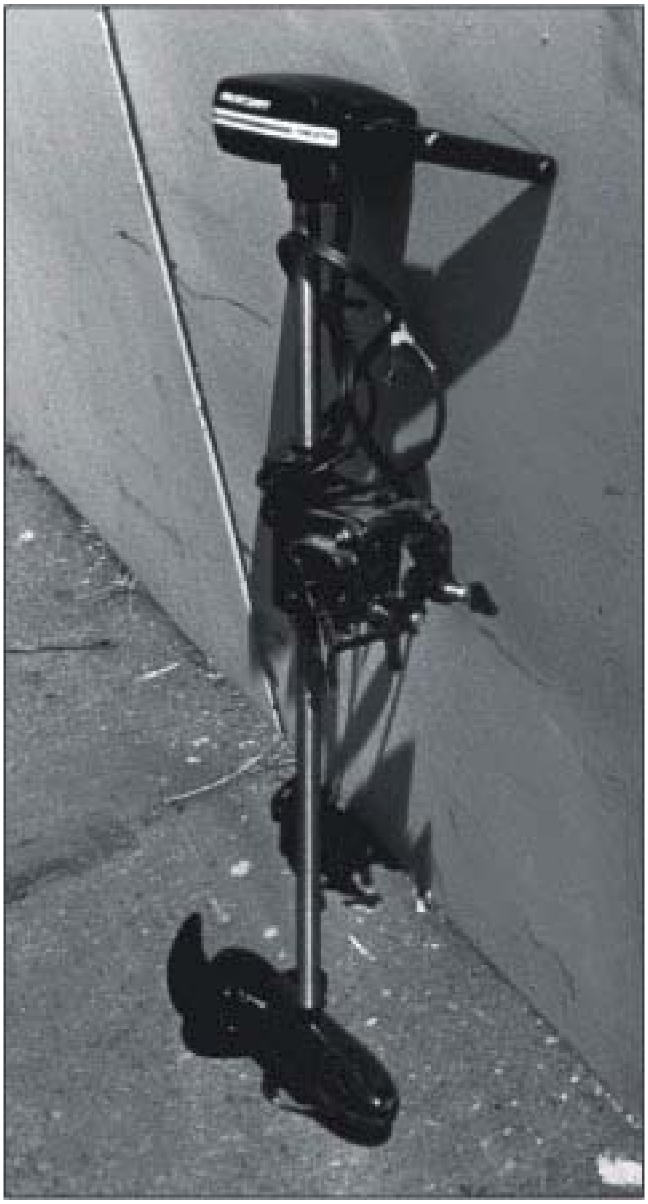

Figure 4.23. Typical battery-operated trolling motor used when making acoustic Doppler current profiler discharge measurements.

sturdy and should be protected from undue twisting and mechanical pressure. The overhang at the back of the deck unit prevents easy disengagement of the bayonet mechanism, and many operators only partially engage the mechanism to facilitate easy removal. A right-angle shell connector can be ordered (when specifying the cable length) that may provide greater protection than the standard shell connector.

The molded underwater connector on the BB-ADCP end of the cable has a plastic alignment key that can become worn. Slight misalignment caused by wear of the alignment key can cause connector pins to bend when mating the connectors and tightening the locking ring. The O rings on both connector ends should be lubricated regularly with silicone grease and the connector rocked slightly to enable proper connector mating. If the alignment key or keyway is worn excessively, the connectors should be replaced.

It is possible that a long, coiled BB-ADCP cable can cause improper BB-ADCP operation. Noise or interference can be introduced (induced) into the coiled cable. Excess BB-ADCP cable should not be coiled, but flaked (using a non-overlapping S-shaped pattern) along the deck. It is best to order a short cable for use when the deck unit is mounted close to the BB-ADCP.

Workhorse Rio Grande

There is no deck unit for the Workhorse Rio Grande ADCP. Power is supplied to the electronics in the pressure case through a combination power and communications cable. The communications cable is terminated with a standard DB-9 RS-232 connector that mates with most laptop communication ports. The power cable is terminated with alligator clips that can be attached to a 12-volt battery. A users guide (R.D. Instruments, Inc., 1999) for connecting and configuring the Rio Grande is provided with the instrument or can be obtained from the RDI web site (www.rdinstruments.com).

Undoubtedly, other equipment will be needed that is unique to each operator or measurement site. Most operators build a “kit” containing ADCP measurement equipment, manuals, and field forms to be loaded before each deployment, thereby reducing the chances of forgetting to pack a vital piece of measurement gear.

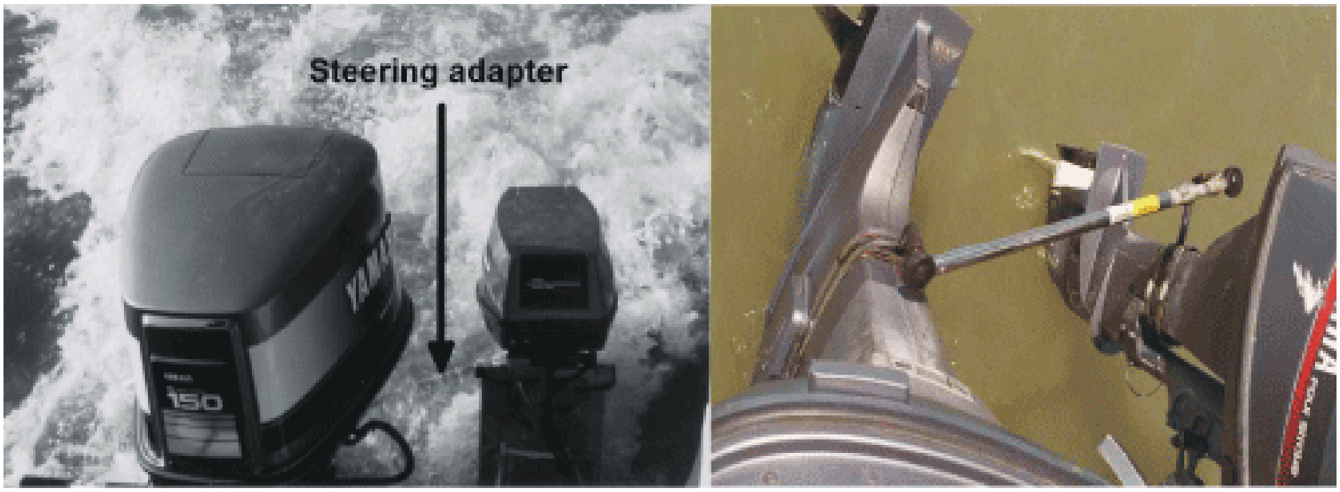

Figure 4.24. Two views of a steering adaptor that connects the trolling motor to the main engine.

Summary

The acoustic Doppler current profiler (ADCP) discharge-measurement system consists of the following items:

An ADCP system with bottom-tracking capability

- Pressure case and transducer assembly
- Power supply and communications interface
- Discharge-measurement software
- Manufacturers’ documentation

Ancillary equipment

- Safe measurement platform or vessel
- ADCP mounting assemblies
- Laptop computer
- Range finder or method for estimating distance to shore
- A knowledgeable ADCP operator and well-trained vessel operator.

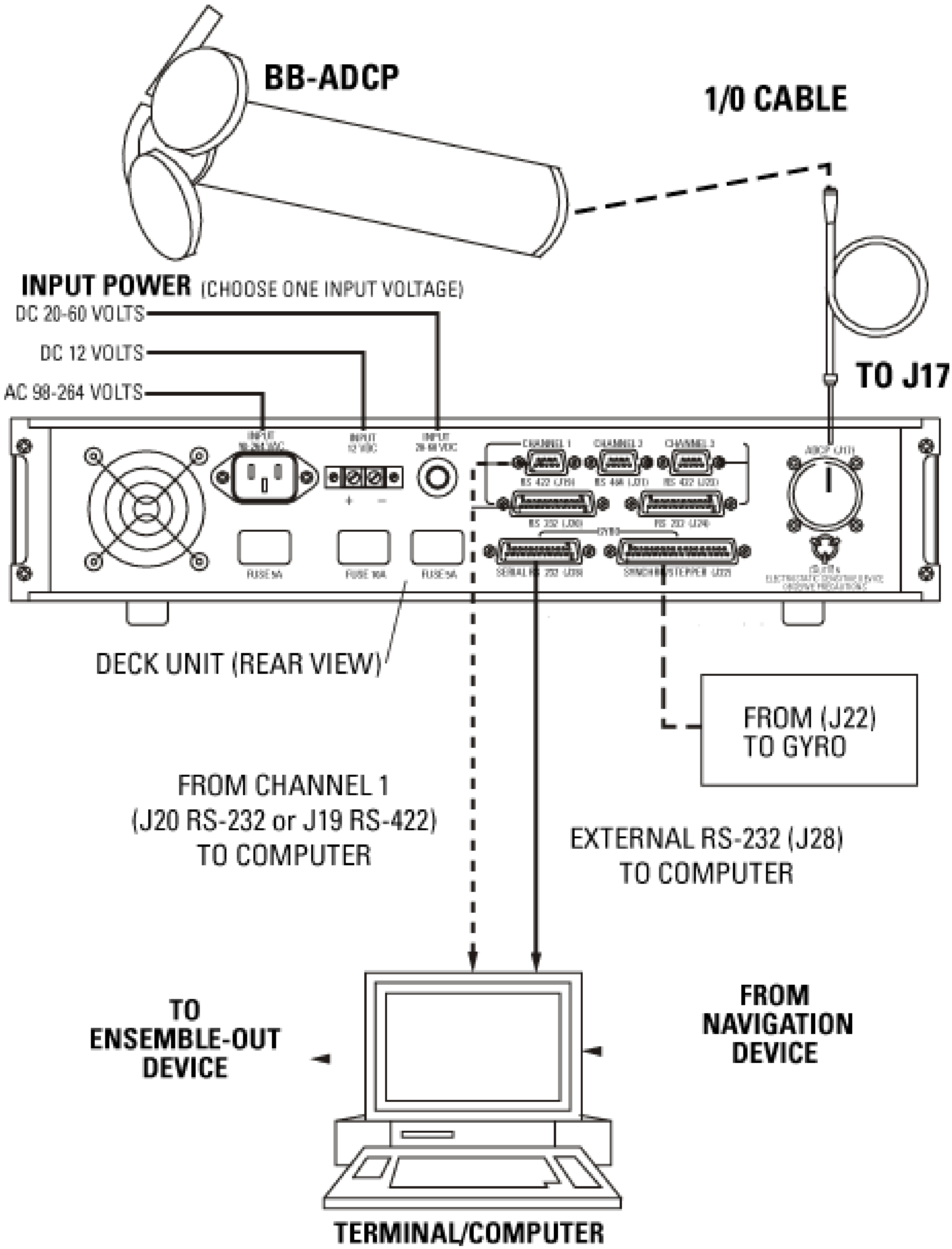

Figure 4.25. Interconnections of the broad-band acoustic Doppler current profiler (BB-ADCP) deck unit with other components of the acoustic Doppler current profiler discharge-measurement system. Adapted from R.D. Instruments, Inc., (1995). DC, direct current; AC, alternating current; V, volt.

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CHAPTER 5: BROAD-BAND ACOUSTIC DOPPLER DISCHARGE-MEASUREMENT SYSTEM CONFIGURATION

Discharge-Measurement Software—"Transect"

Although the BB-ADCP can be used as a velocity-profiling instrument, this report primarily addresses its usefulness as part of a discharge-measurement system. The purpose of this chapter is to discuss proprietary software used to configure the BB-ADCP or Workhorse Rio Grande and to acquire data from these ADCPs to measure discharge. This software is called "Transect." Most of the information covered in this chapter also can be found in the Transect Users Manual for the BB-ADCP (R.D. Instruments, Inc., 1995). This chapter will not dwell on the small details of configuring the BB-ADCP or Rio Grande, but will attempt to touch on the important issues and provide tips to the neophyte ADCP operator.

Transect is composed of a series of stand-alone software modules that incorporate the discharge-measurement algorithms discussed in chapter 2 and also include the following features:

- A graphical user interface
- Graphical output of ADCP velocity and discharge-measurement data
- Tabular output of ADCP velocity and discharge-measurement data
- Command and control interface to the ADCP
- Raw and processed data storage and playback

Transect also includes algorithms for estimating unmeasured parts of the water column and cross section. The Transect software has the ability to accept and record (along with the velocity data) external navigation and depth inputs.

Transect Configuration

The configuration file is at the heart of the Transect software. The configuration file can be thought of as the interface between the ADCP and the Transect software modules. Commands in the configuration file tell the Transect software how to communicate with the ADCP, how to configure the ADCP, and how to modify the ADCP data-collection parameters for proper discharge measurement. It is possible to use the communication, calibration, and planning modules of the Transect software to build a trial configuration file on the basis of rough stream parameters. Although this method is used below to illustrate some of the modules in the Transect software, it is recommended that neophyte operators obtain preliminary configuration files from ADCP training classes or the USGS Office of Surface Water ADCP users' group Web site (http://il.water.usgs.gov/adcp/). Experienced users usually bypass the Transect communication, calibration, and planning modules and directly modify preexisting configuration files using a text editor to fit the desired stream conditions.

To familiarize the reader with the Transect communication, calibration, and planning modules, we will first discuss a method for creating a preliminary configuration file, and then discuss each section of the configuration file, in detail.

Creation of a Preliminary Configuration File Using Transect Modules

Communications Setup

The Transect software provides a communication test and setup whereby the user can establish communication with the BB-ADCP processor. The user also can use any terminal-emulation software or the software supplied by the manufacturer called "BBTALK" to establish communication with the BB-ADCP. BBTALK is a simple terminal emulator with file-capture capability that can be used to initially check the BB-ADCP communication parameters if the Transect software cannot establish communication.

Instructions for using the emulator are in a disk file called 'BBTALK.DOC' that is shipped with the Transect software utilities. If the operator cannot establish communication with the BB-ADCP, then the BB-ADCP technical manual should be consulted and the communications and power connections should be double checked. Different baud rates and bit combinations can be tried on a trial-and-error basis in the event that the BB-ADCP was setup on a nondefault baud-rate/bit combination. This will be practical only for semistandard parity bit and stop bit combinations (for example, no parity bit, eight data bits, one stop bit). It is possible to set the BB-ADCP to a nonstandard baud rate with a combination of stop bits and parity that is difficult (if not impossible) to determine by trial and error. If all standard methods produce "garbage" output to the BBTALK screen, the ADCP should be disassembled and the master reset button on the CPU board should be pushed (R.D. Instruments, Inc., 1995–1999). This will reset the BB-ADCP to factory default communication values. This should, however, be done only after the failure of all other attempts to establish communication with the ADCP.

By using the BB-TALK terminal emulator (fig. 5.1), the operator can invoke the BB-ADCP diagnostics menu with the PT command. PT0 displays

Figure 5.1. BB-TALK terminal emulator help screen.

the test menu. PT200 performs an entire suite of diagnostic tests. The BB-ADCP technical manual provides a detailed description of the diagnostic tests. Parts of the PT200 diagnostic test often will indicate failure if the ADCP transducer assembly is not immersed in water. In fact, certain parts of the PT200 diagnostic test may fail (with a healthy ADCP) if the transducers are immersed in a shallow bucket of water that is placed on a hard surface.

For best results, the diagnostic tests should be performed at the river cross section with the ADCP immersed in water. If the tests must be done in the office or lab, the transducer surfaces should be cleaned with soap and water (to remove grease), and then immersed in a plastic pail of water sitting on a foam pad. The manufacturer should be called if the BB-ADCP fails any of the PT200 suite of diagnostic tests using this scenario. Discharge measurements should not be done if the diagnostic tests indicate a failed subsystem. A PT200 test should be done before every discharge-measurement series, and the test output should be captured to a file and archived.

The communications menu selection of the Transect software main menu (fig. 5.2) allows the operator to establish communication with the BB-ADCP, provides the proper communication parameters for the construction of the configuration file, and provides access to direct (terminal emulation) communication with the BB-ADCP for checkout, configuration, and debugging of configuration problems. The communications parameters established in a session using the communication submenu are added to the communication section of the configuration file.

The communications ADCP submenu (fig. 5.3) provides for the setup and checkout of initial BB-ADCP communication parameters. Once these parameters have been determined, the trial configuration file can be saved with these parameters included. The communication menu also provides for the setup of communications between navigational devices, external readouts, and the external sensors (if any are required). The setup of these devices is covered in detail in the Transect software documentation (R.D. Instruments, Inc., 1999) and is not covered in this report.

Calibration Setup

After establishing communication with the BB-ADCP (and, thereby, setting up communication parameters in the configuration), the operator then should go to the calibration submenu for the next level of configuration file construction. In the calibration menu within the main menu (fig. 5.4), two submenus (offsets and scaling) will help create a “trial” configuration file when saved.

The calibration offsets submenu (fig. 5.5) provides the operator with the opportunity to set the BB-ADCP time and to enter compass alignment offsets (if the compass is separate from the BB-ADCP) or to enter compass magnetic corrections.

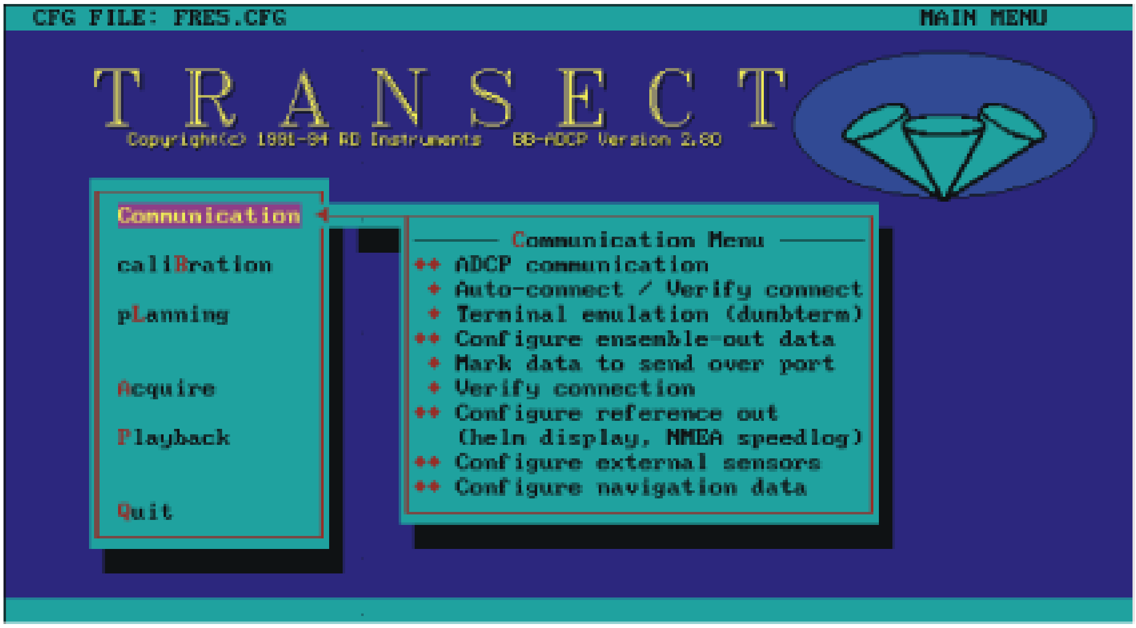

Figure 5.2. Transect main menu showing menu choices. BB-ADCP, broad-band acoustic Doppler current profiler.

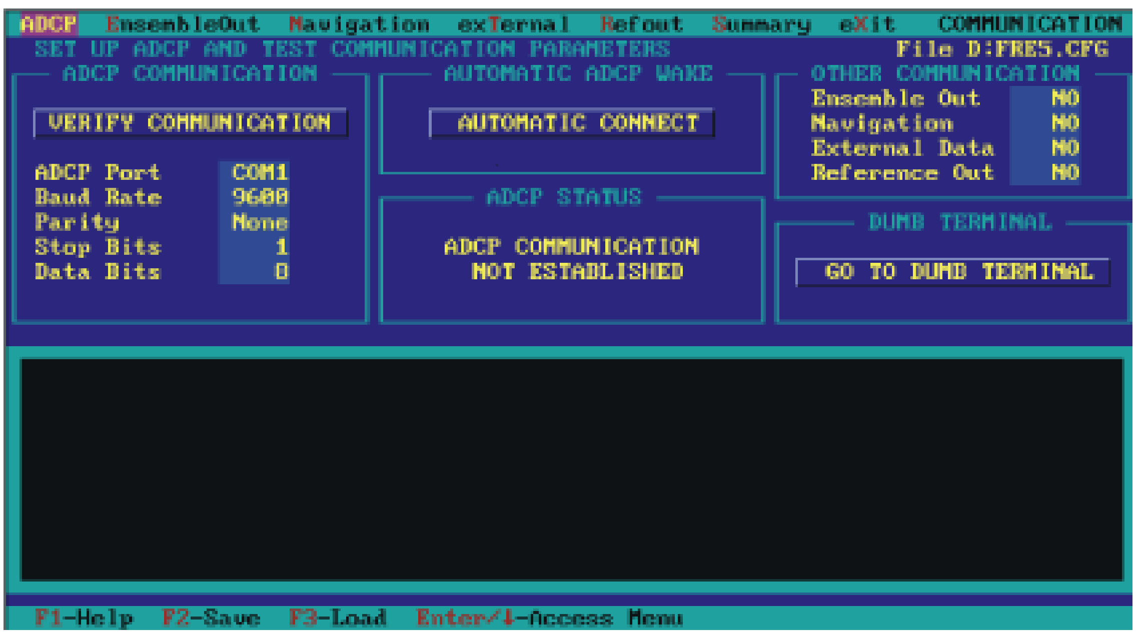

Figure 5.3. Communication acoustic Doppler current profiler (ADCP) submenu.

The next menu entered should be the calibration scaling submenu (fig. 5.6). The calibration scaling submenu provides the operator with the option to change several important velocity-profile scaling and estimation parameters. If salinity at the measurement site is known, or can be accurately estimated, it can be entered in this menu. Speed of sound can be entered manually if it is known, but, in almost all cases, should be computed for each ensemble. The discharge extrapolation scheme should be left at “power” for the top estimation method, and “power” for the bottom estimation method, unless examination of the profiles indicates that these values should be changed or bidirectional flow exists in the measurement cross section. The power-curve exponent also should be left at 0.16670, unless otherwise indicated (chap. 8). Pitch and roll compensation should be left at the default setting of YES, which allows the Transect software to automatically compensate for vessel pitch and roll during the discharge measurement. The absorption coefficient and echo intensity scale also should be left at default values, unless otherwise indicated. The value of these parameters has no effect on discharge- or velocity-measurement results. The configuration file should be saved with the appropriate name upon exiting the calibration menu.

Planning Setup

The next main menu is the planning menu (fig. 5.7). The planning menu, has two submenus (set and ADCP) that, when used properly, will complete the initial creation of the configuration file.

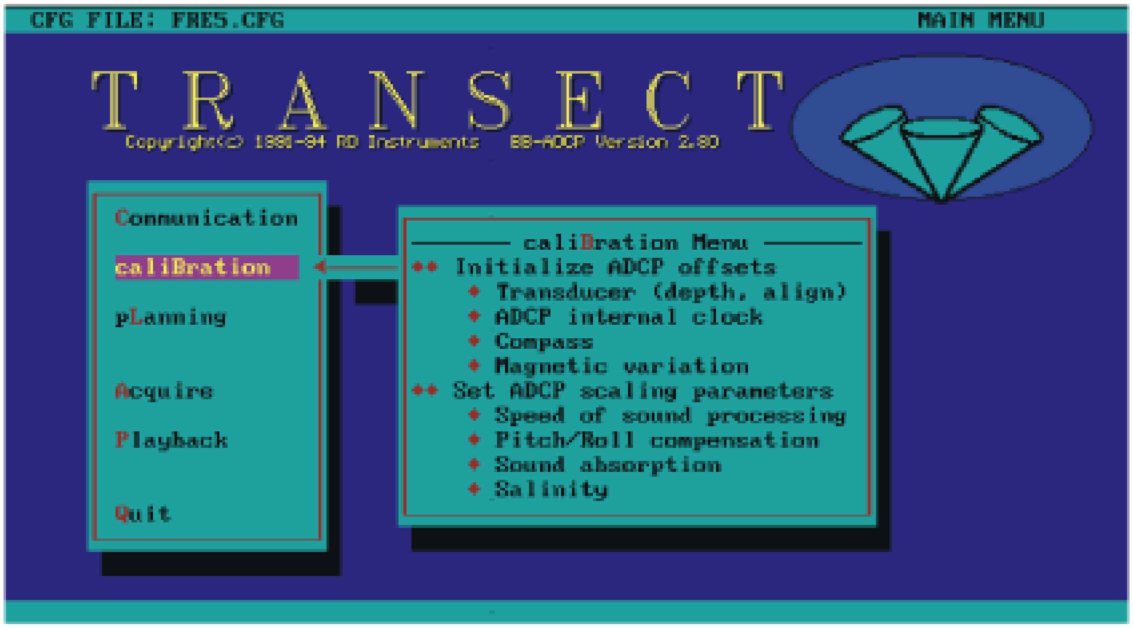

Figure 5.4. Transect main menu showing calibration menu choices. BB-ADCP, broad-band acoustic Doppler current profiler.

Figure 5.5. Calibration offsets submenu screen. ADCP, acoustic Doppler current profiler

The planning setup submenu (fig. 5.8) prompts the operator for the deployment name, primary drive, secondary drive, recorded data types, measurement processing, and engineering units used for tabular and graphics output. If an operating frequency for the ADCP has not been specified, the setup menu will prompt the operator to provide an entry.

The deployment name should be a unique, four-letter identifier for the measurement site. For example, the identifier FRE5 could be used for Sacramento River at Freeport, California, session 5 (fig. 5.8). Future releases of Transect may support the use of a longer identifier. The deployment name has two functions; it becomes the name of a MS DOS root-level directory

Figure 5.6. Calibration scaling submenu screen. ADCP, acoustic Doppler current profiler.

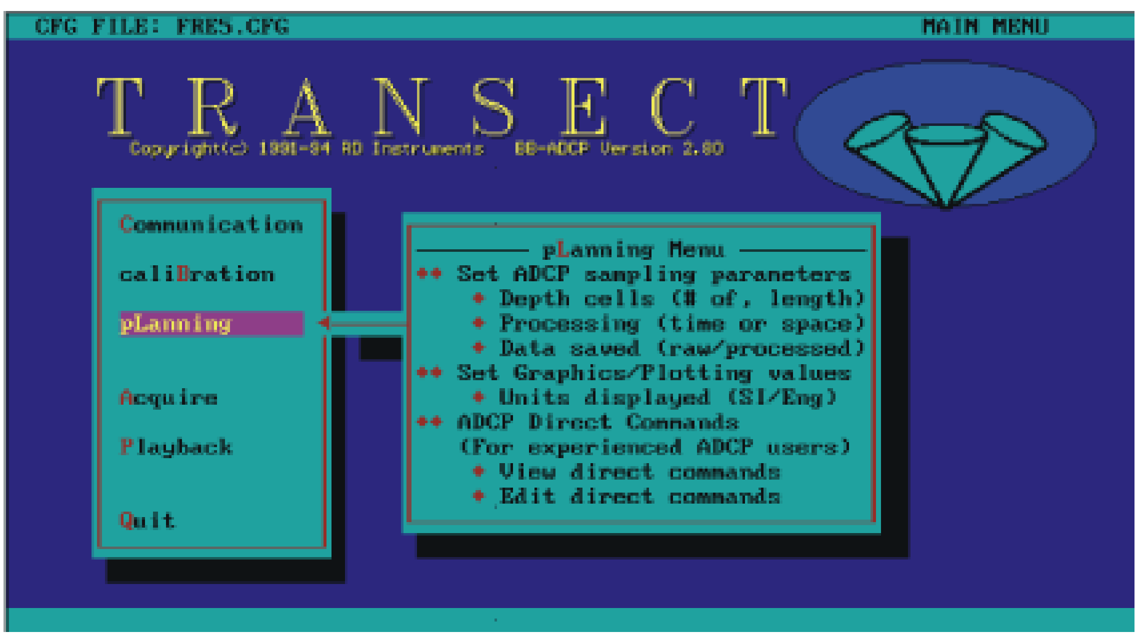

Figure 5.7. Transect main menu showing planning menu choices. BB-ADCP, broad-band acoustic Doppler current profiler.

Figure 5.8. Planning setup submenu screen. ADCP, acoustic Doppler current profiler.

where all ADCP data collected with this configuration will be stored and it also forms the first four characters of each filename of ADCP data.

The primary and secondary drives in the setup submenu are usually the same and are used to construct the data storage path name. For example, data from the above example would be stored in the FRE5 directory on the C drive (C:\FRE5). The secondary drive is used in cases where the Transect software runs out of storage space on the primary drive. When hard disk space is limited, the secondary drive can be changed to indicate another hard disk or a floppy drive.

Data recorded with Transect may be stored in three different types of files: raw, processed (averaged), and navigation. Raw data always should be recorded for USGS discharge measurements. These data provide the operator with the ability to “play back” any discharge measurements that were recorded from unprocessed BB-ADCP data-output files. Processed data can be recorded if additional information needs to be stored during the discharge-measurement series. Raw data files contain unmodified data recorded directly from the ADCP. Processed data files typically contain averaged ADCP data, but also may contain data from an external navigation device, configuration-file data, and estimates of edge discharges.

Navigation data should not be recorded unless the BB-ADCP is connected to external navigation devices such as GPS or Loran C systems. The recording and processing of navigation data requires a recent version of the Transect software (4.00 or later) to execute properly. This report will not cover the operation of external navigation interfaces.

The processing selection (fig. 5.8) controls data averaging done by the Transect software (not in the BB-ADCP) and is used for processed data output. The raw ensemble data can be averaged with time (traverse time) or space (cross-section distance). This setting will affect the number of ensembles that are displayed during a cross-section traverse but will not affect the recording of raw ADCP data. The averaging of raw data is affected by the number of measurement pings averaged by the ADCP firmware (discussed in chap. 6).

The graphics and tabular displays can be annotated in either standard or metric units. This setting does not affect the raw data.

The planning ADCP submenu (fig. 5.9) allows the operator to input ship speed and the length of transect, and then provides the operator with a display of estimated transect time, first and last depth-cell positions, time between ensembles, and standard deviation of individual ensemble velocity averages. The operator also is informed of the amount of available disk space and disk space required for the transect.

If the operator has saved the configuration file at each of the above described menu steps, a configuration file has been created, much like the one in figure 5.10.

The Configuration File, in Detail

As explained in the previous section, the ADCP configuration file is used by the Transect software to communicate with, configure, and control an ADCP.

Figure 5.9. Planning acoustic Doppler current profiler submenu screen. ADCP, acoustic Doppler current profiler.

The configuration file also controls the type of data collected and where the data are stored on the host computer. Configuration files are standard text files that can be opened with a generic text editor.

The first line of a configuration file verifies that this is an official RDI configuration file and must be present for proper loading. If the line becomes altered or corrupted, the operator will get a message that reads “the file is not a Transect configuration file.” If the above described error occurs, the line can be corrected (with the exact text shown in fig. 5.10) using a text editor.

The configuration file consists of the following sections:

- The communications section
- The calibration section
- The recording section
- The ADCP hardware section
- The direct command section
- The processing section
- The graphics section
- The history section

Each section of the configuration file addresses different aspects of ADCP command and control, as well as Transect software data storage and visualization. We will discuss each section of the configuration file in detail in the following paragraphs. Sections within the configuration file are enclosed in braces.

The Communications Section

The first section is the communication section, which sets up the Transect software to “talk” with the ADCP. The section contains directives in the form

```
Device 5sp (Switch sp Port sp Baud-rate sp
Paritybits sp Databits sp Stopbits) [port baud
parity databits stopbits]
```

where

sp = space.

Items in parentheses should be edited to match the device configuration. Items in brackets are reminders or comments and should not be changed. For example, if an ADCP were setup to communicate at 38,400 bauds per second with no parity, eight stop bits, and one data bit through the COM1 port of a computer, the first directive line would read: ADCP (ON COM1 38400 N 8 1) [Port Baud Parity Databits Stopbits].

There are directives for all allowed devices that might communicate with the Transect software through the various computer ports. The ADCP directive line is mandatory; however, the other directive switches should be turned off unless needed (fig. 5.10). These directives also can be set from the communication menu in the Transect software.

Ensemble Out Section

The ensemble out section (fig. 5.10) contains a series of toggles that enable or disable output of the various ensemble data. If the ENSOUT directive in the communication section is ON, then information from

```
BEGIN RDI CONFIGURATION FILE — This line must be first in all RDI configuration files

COMMUNICATIONS — Begin communication section
{
                    Switch  Port    Baud   Parity   Databits   Stopbits
ADCP — A Must         ON    COM1    9600    N         8          1      — Must be set to ADCP rate
ENSOUT               OFF    COM2    9600    N         8          1

NAV — This is for    OFF    COM3    9600    N         8          1
      GPS or Loran                                                        Optional...see
REFOUT               OFF    COM4    9600    N         8          1        explanation in text.
EXTERNAL             OFF    COM5    9600    N         8          1
UseSoftwareBreak (NO) — This is set to yes when using a radio modem.
}

ADCP HARDWARE
{
Firmware       (5.57)
Angle            (20)   This section (ADCP hardware) will fill with pertinent information
Frequency      (1200)   when you start the acquire program (see text).  If you have set these
System         (SHIP)   values incorrectly, you will receive a warning message after the ADCP
Mode              (1)   responds.
Orientation    (DOWN)
Pattern      (CONVEX)
}
```

Figure 5.10. Communication, ensemble out, and acoustic Doppler current profiler (ADCP) hardware sections of the configuration file. RDI, R.D. Instruments, Inc.; GPS, global positioning system.

each ensemble is transmitted from the selected computer port. This section normally is not used for ADCP discharge measurements. Details for obtaining real-time ensemble data are available in the Transect software manual (R.D. Instruments, Inc., 1995). The ensemble out section also can be set up from the communications menu in the Transect software.

Acoustic Doppler Current Profiler Hardware Section

The ADCP hardware section (fig. 5.10) is a list of parameters that describe the ADCP hardware configuration. These parameters are not actually transmitted to the ADCP but are checked against actual ADCP hardware parameters upon ADCP "wake up." Missing parameters are filled in to match ADCP hardware. If the Transect software discovers a discrepancy between parameters in the configuration file ADCP hardware section and configuration data transmitted by the ADCP, a warning is displayed. Additional information regarding this check is given later in this chapter.

Direct Commands Section

Direct commands are commands interpreted by the ADCP, much like a computer operating system interprets commands issued by a user. Direct commands can affect the outcome of a discharge measurement, therefore, it is imperative that the ADCP operator fully understand the purpose and outcome of the basic direct command set. The direct commands section is the most important part of the configuration file (fig. 5.11). Some direct commands are mandatory for proper discharge measurement. Erroneous commands can cause improper operation of the ADCP. The most important of the direct commands are the water- and bottom-mode commands (WM, WV, and BM). These commands were discussed in chapter 3, and are not discussed here.

Some direct commands may be controlled from menus within the Transect software. Direct commands are discussed in detail in the technical manuals for the BB-ADCP, Rio Grande, and narrow-band ADCP (R.D. Instruments, Inc., 1995–1999) and many of them are not referenced in this report. However, an understanding of the most important commands is required for proper creation of configuration files.

Direct commands, like all other BB-ADCP parameters, can be edited into the configuration files without using the Transect software menus. However, the expert mode (alt-M) in the ADCP planning sub-menu provides an easy way to enter direct commands into the configuration file. This mode allows the operator to specify the direct commands that will be sent to the BB-ADCP during Transect initialization (fig. 5.12).

```
DIRECT COMMANDS — Direct command section: These commands are very important
                  and are covered in detail later in chapter 5 of this report.
{
WS25 — Bin size
BX300 — Bottom-track depth
WNXXX — Number of water-measurement bins
WF50 — Blanking distance
WV170 — Mode 1 ambiguity velocity
WZ5 — Mode 5 lag
WD111100000 — Output data types
WM1 — Water mode 1 — Number of bottom pings
WP5 — Number of water pings
BP4 — Number of bottom pings
BM5 — Bottom-track mode
TP000006 — Time between pings
EX10111 — Coordinate transformation flags
ES0 — Salinity
}

RECORDING — Beginning of the ADCP recording setup section
{
Deployment   (FRES) — Unique four-letter deployment name
Drive 1   (C) — Primary data storage drive
Drive 2   (C) — Secondary (or emergency) data drive
ADCP   (YES) — Set YES to record ADCP data (a MUST)
Average   (NO) — Averaged data are not usually recorded
Navigation   (NO) — Set to No external GPS data are recorded
StartRecording   (NO) — Set to yes to turn recording on by default
                        when Transect is first started.
}
```

Figure 5.11. Direct command and recording sections of the configuration file. ADCP, acoustic Doppler current profiler; GPS, Global Positioning System.

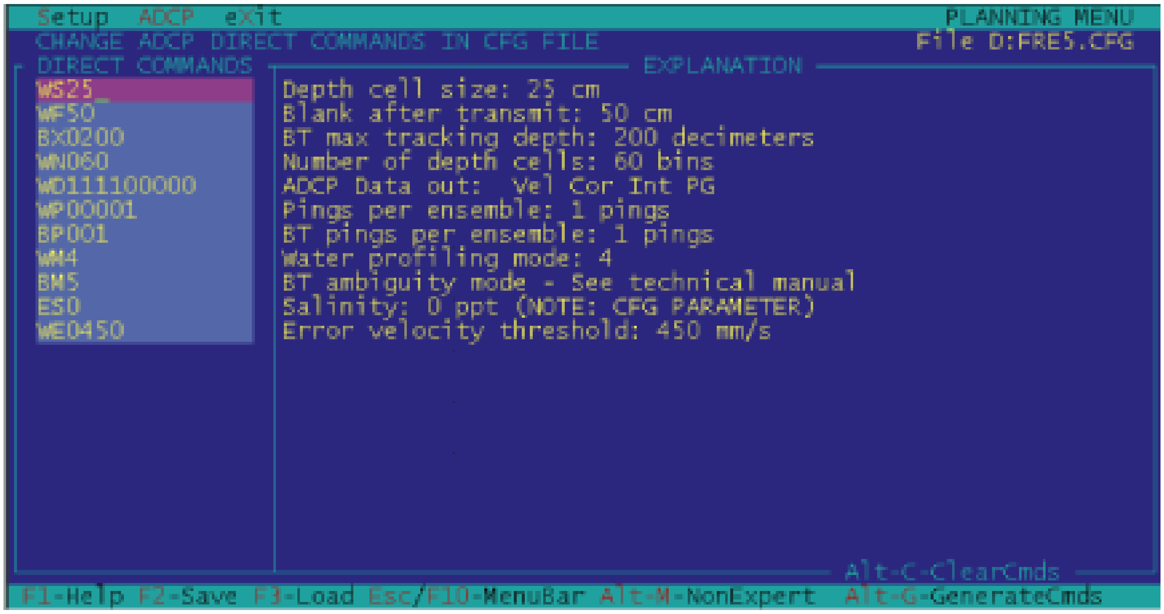

Figure 5.12. Planning acoustic Doppler current profiler (ADCP) menu in expert mode (Alt-M).

The direct command numeric arguments are set by the manufacturer and are in metric units. To avoid confusion, standard-unit conversions will not be presented in the following discussion. All direct commands listed in the technical manual are important; however, some are set by default and almost never change, some are not changed except under rare conditions, and some are changed dynamically by the instrument. Some direct commands must be changed by the operator for optimum BB-ADCP operation in changing environments and are discussed below.

When discussing the direct commands, the syntax for each command will be shown as CCnnnn, where CC is a two-letter command; and nnnn is an integer parameter. For example, the water ping command will be referred to as WPnnnn, where nnnn is the number of water pings averaged for a data ensemble.

Water-Track Commands

WSnnn

WSnnn is the command used to set the length, in centimeters, of the depth cell used for water-velocity measurement (0–999), and controls the vertical resolution of the measured-velocity profile. In most cases, this value of WS can be determined using table 5.1

These settings provide the best resolution in the event that velocity profile information must be extracted from the discharge measurement. By default, these values are placed in the direct command section when a new configuration file is created with the ADCP frequency specified. In some cases, these values may have to be changed (in very deep or very shallow water, for example). Consult the BB-ADCP technical manual before doing so. The WS parameter also may be set in the planning menu of the Transect software.

WNnnn

WNnnn is the command used to set the number of water-velocity measurements (depth cells) in the vertical profile, and can have a numeric range of 1–128. This value should be set so that WS multiplied by WN exceeds the maximum expected depth in the cross section by a safe margin. CAUTION! Failure to properly set this parameter can cause loss of discharge-measurement accuracy, loss of vertical resolution, and incomplete velocity profiles. This parameter also can be set using the planning menu in the Transect software.

WPnnnn

WPnnnn is the command that sets the number of water-velocity measurements (pings) that are averaged together to form a data ensemble (range from 0 to

Table 5.1. Optimum bin size (WSnnn) for acoustic Doppler current profiler (ADCP) discharge-measurement applications

[kHz, kilohertz]

ADCP water mode	WSnnn for 1,200-kHz ADCP	WSnnn for 600-kHz ADCP	WSnnn for 300-kHz ADCP
Mode 1	25	50	100
Mode 5	5	10	20
Mode 8	5	10	20

6384). As a general rule it is recommended that this value be set to 1 because if an ambiguity error occurs, it will not be averaged with other pings and therefore can be readily identified. If data are averaged by using a WP command greater than 1 and an ambiguity error occurs in one of the ensembles, it will be averaged along with the good pings and will cause a bias error that may not be recognized when the data are played back. In situations where many ambiguity errors occur, the discharge measurement will be biased. This bias can occur using water modes 5 and 8 and sometimes is seen using mode 1 during dynamic conditions.

In some cases during low-flow measurements, when using mode 1, a modest number of pings can be averaged to help reduce the standard deviation of the discharge measurement. Averaging pings in the ADCP by using a non-zero WP command can increase the total number of pings collected during a discharge measurement because the ADCP firmware processes data faster than the Transect software. However, using a non-zero WP command is dangerous (because of the possibility of disguised velocity ambiguities) and should be used with caution.

WFnnnn

WFnnnn is a command used to set transducer blanking distance (range 0–9999 cm); the blanking-distance command defines the regions near the transducer faces where no velocity data should be collected. Depth cells close to the transducer faces may be corrupted because transmitted energy has not completely dissipated from the electronics or transducer ceramics. If this command is set too low, it may cause corruption of the first measured velocity bin. This corruption can be very hard to detect. For 1,200- and 600-kHz BB-ADCP units, the recommended minimum setting for this value is 50 for mode 1 and 30 for modes 5 and 8 operation. For Rio Grande units, the recommended setting for this value is 25 for all modes. Minimum recommended values for this parameter also depend upon operating frequency.

WDnnn nnn nnn

WDnnn nnn nnn is the water-data output from the BB-ADCP. The toggles for these parameters are set to 1 or 0 (1 = enabled, 0 = disabled) for the following data: velocity, correlation, intensity, percent good, status, and P0, P1, P2, and P3 (Px = external parameter data 0–3). For example, WD111100000 outputs velocity, correlation, intensity, and percent good.

Bottom-Track Commands

BAnnn

BAnnn is the bottom-track evaluation amplitude minimum (1–255 counts). This command defaults to 30, but can be changed to 25 when bottom movement is suspected. Values lower than 25 should not be used because of the possibility of velocity-measurement contamination by sediment moving above the bottom. When bottom-sediment movement is present, using lower frequency ADCPs (300- or 600-kHz) may sometimes help eliminate bottom-movement bias (chap. 3) (example BA25).

BCnnn

BCnnn is the bottom-track correlation magnitude minimum (1–255 counts). The BB-ADCP flags any data having a correlation magnitude less than this value as bad data—perfect correlation (solid target) is 255 counts and the default value is 220 counts. This value can be set slightly lower when bottom tracking is difficult to acquire (example BC210).

BPnnn

BPnnn is the number of bottom pings that are averaged for each data ensemble (1–999 pings). This value should be set to the same value as that of the WP command, or one less than the WP command if more than one water ping is averaged for each data ensemble (example BP01).

BXnnnn

BXnnnn is the maximum bottom-track search depth, in decimeters [80–9999 decimeters (dm)]. This value should be set to match the deepest expected depth plus a safety factor. CAUTION! Error in this parameter in water deeper than 8 m can cause loss of bottom track and invalid discharge measurements because of missing ensembles. This parameter is set in decimeters, rather than centimeters, and, therefore, is more prone to operator setup errors (example BX100).

&Rnn

The &Rnn command, while not a standard bottom-track command, must be set properly in the BB-ADCP because the default setting is not optimized for river discharge measurement. The value nn is the length of the bottom-track pulse, in percent of total depth. In BB-ADCP firmware, the default for this is 30 (30 percent). The manufacturer suggests that a value of 20 (20 percent) is more applicable to riverine environments. The recommended setting for this command is &R20, and it should be included in the direct commands section of the configuration file so that the default value is overwritten.

General Commands

ESnn

ESnn is the estimated salinity, in parts per thousand (0–40). It is important to set this parameter properly because the BB-ADCP default setting is for open ocean (ES35), which can cause discharge-measurement errors in freshwater if undetected. An ES0 command is necessary in the configuration file if measuring freshwater. Salinity in brackish or oceanic waters should be measured with a salinimeter. Unless the salinity is known, this command always should be set for zero salinity (ES0) because the value can be changed after the fact in the Transect calibration section (if it is discovered that brackish water was present, for example). If the value is set to the wrong salinity (other than 0) in the direct command section, it is much harder to correct the resulting discharge values.

EXnnnnn

EXnnnnn is the set of coordinate transformation flags, where each n in the command is set to a 1 or a 0, according to the following encoding scheme:

- EX00nnn = no transformation (beam coordinates)
- EX01nnn = instrument coordinates
- EX10nnn= ship coordinates
- EX11nnn = Earth coordinates
- EXnn1nn = uses tilts (pitch and roll) in transformation
- EXnnn1n = allows three-beam solutions if one beam is below WC threshold
- EXnnnn1 = allows bin mapping

This command allows the BB-ADCP to transform beam coordinates into other coordinate systems. The Transect software can do the above transformations if radial-beam velocities (beam coordinates) are recorded (the default mode). For robust operation, the BB-ADCP probably should be set for ship coordinate transformation because the data are transformed in the Transect software rather than adjustments made to the raw recorded data.

If velocity profiles are required, it is preferable to collect raw data in beam coordinates because of the difficulty in changing coordinate systems after conversion to Earth coordinates. (It is difficult to “back out” raw-beam coordinates if there is no ping-by-ping record of the corrections for pitch, roll, and heading.)

When recording in ship or beam coordinates while averaging ensemble data in the profiler, pitch, roll, and sharp boat movements and heading changes should be kept to a minimum. Corrections for these events are calculated by the Transect software at the end of the ensemble (not for each ping). For example, if averaging is set to five water pings and five bottom-track pings per ensemble and beam coordinate transformation is selected, coordinate transformation and pitch and roll correction will not occur until the averaged ensemble is transmitted to the computer from the ADCP. In the above case, the transformation and correction occurs at the end of a 4- to 5-second interval. If the boat has pitched or rolled significantly during the 5-second period, the correction may be applied incorrectly or not applied at all. For velocity coordinates, the Transect software calculation is not affected by the coordinate system being used, however the software does require exact synchronization between the bottom-track vector and the water-track vector. If both coordinates are Earth transformed at the end of a 5-second interval and there are abrupt heading changes during the interval, the synchronization of these vectors may not be achieved because of time/phase lag in the onboard flux-gate compass. For these reasons, despite the lower ADCP ping-rate performance, the WP and BP commands probably should be set to average 1 ping for each data ensemble (WP01 and BP01) in windy conditions or conditions with a significant amount of pitch and roll.

Another reason for setting WP and BP to 1 is so ambiguity errors (chap. 3) will be more apparent. If data are averaged along with an ambiguity error, the error could be masked because of the averaging. This can be especially devastating in mode 5 because ambiguity errors are more likely to occur.

Pitch and roll corrections should be applied, unless the tilt sensors are defective. If tilt sensors are transmitting invalid data, they can be disabled to collect discharge data.

In most cases, three-beam solutions always should be enabled so that velocities can be calculated in the event that data are lost from one beam, however, there is some controversy as to the proper setting for three-beam solutions. Please check the USGS ADCP users web site (http://il.water.usgs.gov/adcp/) for late-breaking instructions.

Bin-depth mapping should be enabled so that the measurement bins are kept at the same depth for each beam during a pitch and roll event.

For example, an EX00111 command does no coordinate conversion (beam coordinates, uses pitch and roll in the transformation, allows three-beam solutions for missing beams, and allows bin-depth mapping for pitch and roll).

Recording Section

The recording section of the configuration file (fig. 5.11) contains information that is used by the

Transect software to set up the data recording paths, as well as specifications for drive priority, averaged data recording, and navigational data recording. Required sections are as follows:

- Deployment (cccc), where cccc is a four-character file name to be used as a prefix for the data file. For example, if the operator picks deployment (TUFA), resulting file names will be TUFA001r.000, TUFA002r.000, and so forth. The deployment name and configuration file name should be the same to keep the correct configuration file synchronized with the correct data set (version 2.72 and earlier). Version 2.80 (and later) of the Transect software stores a configuration file with each transect, thereby eliminating the synchronization problem.
- Drive 1 (d) where d is the path name for the primary data-storage drive. For example, if drive C:\ is the primary data drive, then the proper directive is drive 1 (C).
- Drive 2 (d) where d is the path name for the secondary data-storage drive. For example, if drive C is nearly full and is the primary data-storage drive, the Transect software will automatically switch to the secondary storage drive upon filling C drive with data. If a formatted floppy disk is placed in drive A for such an emergency, then the proper directive would be drive 2 (A).
- ADCP (YES/NO) specifies that the Transect software record (or not record) ADCP raw (unaveraged) data. This always should be set to YES.
- Average (YES/NO) specifies that the Transect software record (or not record) averaged data. This directive usually is set to NO, unless the operator wishes to record averaged data. Because raw data can be averaged on playback, this directive usually is not needed, even if averaged data are desired.
- Navigation (YES/NO) specifies that the Transect software record (or not record) external-navigation data. This is set to YES if external-navigation data from Loran C or GPS systems are to be recorded with each ensemble. Any external RS-232 data can be recorded in this manner and synchronized with the ADCP data.

Calibration Section

The calibration section of the configuration file (fig. 5.13) contains important information that supplies the Transect software with data that are vital to proper coordinate transformation and discharge calculation. Note that these data can be changed upon playback and are not part of the raw data file.

- ADCP depth, in meters, is the draft (depth below water surface) of the ADCP transducer faces. This parameter is used by the Transect software to calculate the depths at the bin centers and is vital to the proper calculation of the curve fit estimation data as well as subsection depth.
- Heading/magnetic offsets are values that are primarily used to correct the internal flux gate compass of an ADCP to true north. One parameter adjusts for magnetic anomalies (such as metal objects), whereas the other adjusts for magnetic declination obtained from navigational charts or maps.
- Transducer misalignment is a value that is nonzero only when the compass is separate from the transducer assembly. This value is used to correct the azimuth of the transducer assembly to the azimuth of the compass (in degrees), and is primarily used with gyroscopic-based heading systems.
- The intensity and absorption values are scale factors used to correct the raw, backscattered intensity counts from the ADCP into decibel values corrected for receiver gain and range. The intensity scale factor is used to convert raw counts to decibels and should be left at the default value unless other values are indicated. From the calibration menu, the absorption value can be set to a default value, set to a known value, or calculated by the Transect software as a function of frequency, water temperature, and salinity. All three choices can be made from the Transect calibration software by tabbing to the appropriate selection in the sound absorption coefficient part of the scaling submenu.
- Salinity should be set to the measured or estimated salinity at the measurement site.
- Speed-of-sound correction and pitch-and-roll compensation normally should be set to YES, unless the temperature or tilt sensors are providing erroneous data.
- Tilt misalignment, pitch offset, and roll offset normally are set to zero unless the tilt sensors are mounted external to the ADCP case.
- Top discharge estimate can be set to POWER or CONSTANT. If it is set to POWER, then the Transect software uses the power-curve coefficient to estimate velocities in the unmeasured area near the water surface. If it is set to CONSTANT, then the Transect software

CALIBRATION — ADCP calibration section (discussed in detail in chapter 5 of this report).

{

ADCP depth (0.16 m) — ADCP draft (distance below water surface).

DBTDraft (0.00 m) — Depth sounder draft (if an external depth sounder is used).

Heading / Magnetic offset (0.00 10.00 deg) — For setting compass alignment to true north.

Transducer misalignment (0.00 deg) — For aligning compass to ADCP (if compass is separate).

Intensity scale (0.43 dB/cts)
Absorption (0.278 dB/m)
— Normally left at default values.

Salinity (0.0 ppt) — Set to correct salinity value here (or zero if in doubt).

Speed of sound correction (YES)
Pitch & roll compensation (YES)
— Normally set to YES.

Tilt Misalignment (0.00 deg)
Pitch_Offset (0.000 deg)
Roll_Offset (0.000 deg)
— Normally set to 0.00 unless the tilt sensors are mounted external to the ADCP case.

Top discharge estimate (POWER)
Bottom discharge estimate (POWER)
— Normally set to POWER.

Power curve exponent (0.1667) — Normally set to 0.1667 unless the velocity profiles appear to be nonstandard.

}

Figure 5.13. Calibration section of the configuration file. ADCP, acoustic Doppler current profiler.

uses the same cross product as is used for the uppermost measured bin to estimate near-surface, unmeasured discharge. Chapter 8 contains a discussion on how to examine the measured profiles to determine the proper estimation technique.

•Bottom discharge estimate can be set to POWER or CONSTANT. If it is set to POWER, then the Transect software uses the power-curve coefficient to estimate velocities in the unmeasured area near the channel bed. If it is set to CONSTANT, then the Transect software uses the same cross product as is used for the bottom-most measured bin to estimate near-bottom, unmeasured discharge. Chapter 8 contains a discussion on how to examine the measured profiles to determine the proper estimation technique.

•Power-curve exponent usually is set to 0.1667 for a “Manning-like” water-velocity profile. Under most conditions, this value should be set to the one-sixth power setting (0.1667), even in the estuary. A good test of this value is to pick a transect and average a series of ensembles in the deeper, faster part of the cross section. The averaged profile then should be then viewed from the discharge profile plot in the Transect software playback menu. If the plotted power curve fits the data points, the one-sixth exponent value can be used. If the plotted power curve does not fit the data, other exponent values can be tried until a good fit is obtained. If the velocity profile is distinctly nonstandard, or crosses zero (bidirectional) then a power-curve fit should not be used (use CONSTANT for top and bottom velocity estimates). This technique will be discussed in more detail in chapter 8.

Processing Section

The processing section of the configuration file (fig. 5.14) contains directives to the Transect software that control ensemble averaging, profiled depth, and internal depth-sounder data, as well as directives that control the output of an external velocity monitor (refout):

- Average every () directive can be set to a time value or a spatial value. For example, if the value is set to "average every [5.00 seconds (s)]," then the Transect software will display an averaged output to the console every 5 s. This parameter also can be set to a metric distance value. "Average every (5.00 m)" will send an averaged output to the console every 5 m (16 ft). During data acquisition (acquire) it usually is best to set this value to zero for faster updates to the computer screen. The setting of this value will not affect the raw-data file.
- Depth-sounder value must be set [(YES) or (NO).] If the ADCP has an internal fifth-beam depth sounder, this value should be set to YES; otherwise, it should be set to NO. (This normally should be set to NO, unless you have a special system.)
- BTM layer percent () is a value that overrides the normal maximum bottom profile range percentage (85 percent with 30º transducer angle and 94 percent with 20º transducer angles). This directive need not be used unless the operator wishes to change the default profiling range for the ADCP. This change must be made for old firmware versions for mode 5 operation and for other special circumstances. The accuracy of the Transect software output data can be seriously degraded if this value is set incorrectly. Inclusion of this command is not recommended unless you are trying to use water mode 5 with an older BB-ADCP with phase 2 firmware.

The remainder of the values in the processing section are not discussed in this report, and are used only if data are being sent to an external reference via an RS-232 port. Information on these settings is in the BB-ADCP or Rio Grande technical manual (R.D. Instruments, Inc., 1995–1999).

Graphics Section

The graphics section of the configuration file controls the Transect software display scaling factors. This section is best changed from within the Transect software in either the Acquire or playback software using the F6 special function key. These settings are discussed in chapters 6 and 8.

History Section

The history section of the configuration file is modified by the Transect software. This section gives the version number of the Transect software used with the configuration file and should not be changed by the operator.

Finishing the Preliminary Configuration File: Required Commands

Before the preliminary configuration file that we created in the first part of this chapter can be used for data collection, some additional commands must be added, either by using an editor or by using the expert mode in the Transect software calibration menu. The sections must be checked, changed, or modified (figs. 5.15–5.18).

Entries in the ADCP hardware section that are added by the Transect software during the first run of the Acquire module are shown in figure 5.15. These entries also can be added using a text editor such as Microsoft Disk Operating System (MS DOS) Edit. The Transect software will check the values against values returned from the ADCP and will deliver a warning to the operator if they do not match.

Entries in the direct command sections that must be checked and entered manually, if necessary, also are shown in figure 5.15. The command syntax and purpose are discussed in the Direct Commands Section earlier in this chapter. The critical entries to check are as follows:

- WPnnn is the water pings per ensemble. This value normally should be set to 1 (example WP001).
- BPnnn is bottom pings per ensemble. This value normally should be set to the same value as the WP value (example BP001).
- ESnn is estimated salinity, in parts per thousand. This value should be set to zero, unless the operator is sure of the actual salinity value (example ES0). The Transect software can calculate speed-of-sound using salinity values after-the-fact.
- EXnnnnn is for coordinate transformation. If beam coordinates are selected, then EX00111 should be used.
- BXnnnn is bottom-track maximum search depth, in decimeters. This value should be set slightly deeper than the expected maximum depth at the measurement site. Loss of bottom track can result if this value is too shallow, and

PROCESSING — Beginning of the ADCP processing parameter section.

{

Average every (0.00 s) — Normally set to 0.00 unless you are data averaging

Use Depth Sounder (NO) — Set to NO unless the ADCP has a depth-sounder beam.

```
MaxFileSize (1200)
External_formats (N N N N N) [HDT HDG RDID RDIE]
External_decode (N N N N) [heading pitch roll temp]
Start_Shore_distance (-1) [cm]
End_Shore_distance (-1) [cm]
```

These data should be left alone unless the ADCP output is being sent to an external monitor or device other than the computer running the Transect software.

```
Edge_distance_prompt (NO)
Use GPS For Btm (0)
}
```

GRAPHICS — Graphics parameter section.

```
Units (English)
Velocity Reference (BOTTOM)
East_Velocity (-1.0  1.0  ft/s)
North_Velocity (-1.0  1.0 ft/s)
Vert_Velocity (-0.5  0.5 ft/s)
Error_Velocity (-0.5  0.5 ft/s)
Depth (1   35 bin)
Intensity (50  200 counts)
Discharge (-1  1 ft3/s)
East_Track (-211  211 ft)
North_Track (-190  231 ft)
Ship track (1 bin  0.5 ft/s)
Proj_Velocity (-1.0  1.0 ft/s)
Proj_Angle (250.0 deg from N)
```

These values are set in the Transect program and should not be changed directly by editing the configuration file.

```
Bad_Below_Bottom (YES)
Line1 ('Standard' Config file for 1200 kHz)
Line2 (Mode 1 -- 25cm bins -- 5 WP 4 BP -- Ship)
```

Information stored in these lines is displayed on Transect's output data plots.

```
}

HISTORY
{
SOFTWARE (BB-TRANSECT)
Version (4.05)
}
```

This section should not be modified. Transect stores the version number here that was used to collect discharge data.

END RDI CONFIGURATION FILE — This is a required end-of-file statement.

Figure 5.14. Processing, graphics, and history sections of the configuration file. ADCP, acoustic Doppler current profiler; GPS, Global Positioning System; RDI, R.D. Instruments, Inc.

```
BEGIN RDI CONFIGURATION FILE
COMMUNICATIONS
{
ADCP  (ON COM1 9600 N 8 1) [Port Baud Parity Databits Stopbits]
ENSOUT(OFF COM2 9600 N 8 1) [Port Baud Parity Databits Stopbits]
NAV  (OFF COM3 9600 N 8 1) [Port Baud Parity Databits Stopbits]
REFOUT(OFF COM4 9600 N 8 1) [Port Baud Parity Databits Stopbits]
EXTERNAL (OFF COM5 9600 N 8 1) [Port Baud Parity Databits Stopbits]
UseSoftwareBreak (NO)
}
ENSEMBLE OUT
{
ENS CHOICE (NNNNNNNN)[Vel Corr Int %Gd Status Leader BTrack Nav]
ENS OPTIONS (Bottom 1 8 18) [Ref First Last Start End]
ENS TYPE (RAW) [RAW (default) or AVERAGED data transmitted]
}
ADCP HARDWARE
{
Firmware (5.57)
Angle (20)
Frequency (1200)
System (SHIP)
Mode (1)
Orientation (DOWN)
Pattern (CONVEX)
}
```

This section now has information that should correspond to the current ADCP hardware on your system.

```
DIRECT COMMANDS
{
BX200 — The maximum bottom-track depth is 200 decimeters (20 meters).
WS50 — Water bin size is 50 centimeters.
WN060 — Set for 60 depth bins.
WF50 — Blanking distance is 50 centimeters.
WV170 — Mode 1 ambiguity velocity is set for 170 centimeters per second.
WD111100000 — Data collected are velocity, correlation, intensity, and percent good.
WM1 — Water-measurement mode 1.
WP1 — One water ping averaged per ensemble.
BP1 — One bottom ping averaged per ensemble.
BM5 —Bottom-measurement mode 5.
EX10111 — Coordinates are ship, with pitch and roll correction and bin mapping enabled.
ES0 — Salinity is set to zero.
&R20 — Bottom-track bin size is set to 20 percent of the measured depth.
}
```

Figure 5.15. Hardware and direct command sections of the configuration file. RDI, R.D. Instruments, Inc.; ADCP, acoustic Doppler current profiler.

```
RECORDING
{
Deployment  (FRE5) — Make sure to update this deployment name when
                     using the CFG file in another area.
Drive 1  (C)
Drive 2 (C)
ADCP (YES)
Average (NO)
Navigation (NO)
StartRecording (NO)
}
```

Figure 5.16. Recording section of the configuration file. ADCP, acoustic Doppler current profiler; CFG, configuration (file).

excessive ensemble times can result if it is too deep. For example, a BX0250 command sets the bottom-track maximum search depth at 25 m.

- WMnn, BMnn, and WVnnnn are water and bottom mode commands. These commands should be added per instructions in chapter 3.

The recording and calibration sections of the completed configuration file are shown in figures 5.16 and 5.17, respectively. If the configuration file is renamed for use at another measurement site, the four-character deployment name must be changed to one matching the new site. If the configuration file is reused at another site, the proper transducer draft must be entered. Failure to do so can cause significant errors when measuring shallow/wide rivers. The two-line comment in the graphics section (fig. 5.18) also should be updated when reusing the configuration file.

Transect Release Enhancements (2.80 and Later)

For purposes of brevity, Transect software releases 2.80 and later hereafter will be referred to as Transect 2.80+. The following enhancements are included in Transect software release 2.80+:

- A copy of the configuration file is saved with each discharge data file with the letter C imbedded in the file name. Example—If the raw data file name is JUNK001R.000, then the configuration file is JUNK001C.000.
- The user is prompted for starting and ending edge distances. These values are stored in the configuration file and in the processed data file, if one has been generated.
- The unique configuration file can be loaded automatically and used during the Transect software playback.
- The Transect module “Acquire” starts with recording turned off. This feature eliminates two keystrokes at the start of each measurement. Percent good is redefined by the user in processed data files.
- The Transect software will extrapolate discharge in missing bins.
- Default data file size is changed from 300 kilobytes (K) to 1,200 K.
- Other enhancements are included as detailed in the Transect version 2.80 software documentation.

Transect 2.80+ operation requires some additional commands within the configuration file and at the DOS prompt (or in the Autoexec.bat file).

Earlier versions of the Transect software allowed only for a triangular-shaped edge slope. Transect 2.80+ allows the operator to select an edge slope that can vary from square to no slope at all (fig. 5.19). Entering a -1 directs the Transect software to use a triangular-shaped edge slope (default). Entering a -2 directs the Transect software to use a square-edged slope, and entering a value between 1 and 0 directs the software to use that value as a slope coefficient where 0.91 is nearly square, 0.35 is almost triangular, and 0.05 is nearly flat (fig. 5.19).

In the processing section of the configuration file, there are three new items used by Transect 2.80+. If Edge_distance_prompt is set to YES, then the software will prompt the operator for edge-distance estimates during data acquisition (acquire). The values that are entered by the operator are saved in the configuration file in the Start_Shore_distance and the End_Shore_distance variables (fig. 5.20).

Several DOS environmental variables also must be set before running Transect 2.80+. DOS environmental variables can be compared to memory "mail boxes." The system operator puts a directive into a mail box, and when the Transect starts, it checks the mail box, reads the mail, and takes appropriate action. In the case of Transect 2.80+, four environmental variables (mail boxes) are used to send directives to the Transect software. The first environmental variable is typed at the DOS prompt, or in the Autoexec.bat file; (set AUTOSAVECFG = Y). This environmental variable tells the Transect software to save a configuration file with each save of a raw- (or processed-) data file. The file names have the following form. If the deployment name in the RECORDING section of the configuration file is, ARKN, for example, then the files saved are

- •ARKN001R.000 for the raw-data file;
- •ARKN001P.000 for the processed-data file (if requested);
- •ARKN001C.000 for the configuration file (this is the new one!);
- •ARKN001N.000 for the navigation file (if requested).

```
CALIBRATION
{
ADCP depth (0.16 m)
DBTDraft (0.00 m)
Heading / Magnetic offset (0.00  0.00 deg)
Transducer misalignment (0.00 deg)
Intensity scale (0.43 dB/cts)
Absorption (0.278 dB/m)
Salinity (0.0 ppt)
Speed of sound correction  (YES)
Pitch & roll compensation (YES)
Tilt Misalignment (0.00 deg)
Pitch_Offset (0.000 deg)
Roll_Offset (0.000 deg)
Top discharge estimate (POWER)
Bottom discharge estimate (POWER)
Power curve exponent (0.1667)
Edge_slope coefficient (-1.00000) [-1=Trianglar(0.3535):-2=Square(0.91):User]
OneCycleK (0.0000000)
OneCycleOffset (0.0000000)
TwoCycleK (0.0000000)
TwoCycleOffset (0.0000000)
DBTOffset (0.00 m)
DBTScaleFactor (NO)
GPSLead (0.00 s)
}
```

— This value must be updated when copying the CFG file for use in a new deployment.

Figure 5.17. Calibration section of the configuration file. ADCP, acoustic Doppler current profiler; GPS, Global Positioning System.

(Graphics section in part)

```
Proj_Angle (250.0 deg from N)
Bad_Below_Bottom (YES)
Line 1 (Sacramento River at Freeport)
Line 2 (Mode 1 -- 25cm bins -- 5 WP 4 BP -- Ship)
}
HISTORY
{
SOFTWARE (BB-TRANSECT)
Version (4.05)
}
END RDI CONFIGURATION FILE
```

Remember to update this two-line message when redeploying the ADCP in a new area

Figure 5.18. Graphics and history sections of the configuration file. ADCP, acoustic Doppler current profiler; RDI, R.D. Instruments, Inc.

If AUTOSAVECFG = N or is missing, the Transect software will not save a configuration file when it saves a data file.

The second environmental variable is AUTOLOADCFG. Transect 2.80+ will autoload the matching configuration file when a data file is loaded for playback if the environmental variable AUTOLOADCFG is set to Y; (set AUTOLOADCFG = Y). These first two directives greatly enhance the post-processing of the Transect software data files. Although still necessary, the operator is not dependent only upon the log sheets for the recording of edge distance estimates. The operator also will be assured that changes to the transducer draft and other configuration directives will not be inadvertently applied to the wrong data files during playback.

The third environmental variable is STARTRECORDOFF, which can effectively eliminate one minor annoyance that is present in earlier versions of the Transect software; (set STARTRECORDOFF = Y).

This variable tells the Transect software to start the Acquire software with the data recording toggled OFF. Many operators prefer to start the cross-section traverse with the recording turned off because discharge should not be collected with zero good bins or only one good discharge bin. Recording can begin when the operator observes that velocities are being properly measured (chap. 7). Older versions of the Transect software started with recording turned on and the operator was required to toggle recording off before starting ADCP data collection.

The fourth and final environmental variable relates to the collection of processed-data files. Older versions of the Transect software used an unusual definition of percent good to describe the data in each averaged bin (number of good four-beam and three-beam Earth transformations). In Transect 2.80, the operator can define the meaning of percent good in a processed-data file by setting the following environmental variables; (set USEPERCVEL = Y).

If this variable is set to Y, percent good will equal the number of good velocity values in each bin, averaged together by the Transect software; (set USEPERCQ=Y).

If this variable is set to Y, percent good will equal the number of good discharges in each bin averaged together by the Transect software. Note: the “redefined” percent good will be saved to the processed-data files, but nothing is saved to indicate which of the above two definitions were used.

To ensure that the above environmental variables are set each time the Transect software is run, the operator should edit them into the Autoexec.bat file in the boot drive root directory.

The additions to the Transect configuration file, discussed above, can be entered with a text editor or added from the Transect software calibration menu. In the Transect software calibration menu, the

```
CALIBRATION
{
ADCP depth (0.16 m)
DBTDraft (0.00 m)
Heading / Magnetic offset (0.00  0.00 deg)
Transducer misalignment (0.00 deg)
Intensity scale (0.43 dB/cts)
Absorption (0.278 dB/m)
Salinity (0.0 ppt)
Speed of sound correction (YES)
Pitch & roll compensation (YES)
Tilt Misalignment (0.00 deg)
Pitch_Offset (0.000 deg)
Roll_Offset (0.000 deg)
Top discharge estimate (POWER)
Bottom discharge estimate (POWER)
Power curve exponent (0.1667)
Edge_slope coefficient (-1.00000) [-1=Trianglar(0.3535):2 =
    Square(0.91):User]
}
```

- Enter "-1" for a Trianglar edge slope (0.3535) (default)
- Enter "-2" for a Square edge slope (0.91)
- Enter a coefficient between 0 and 1 (see diagram)

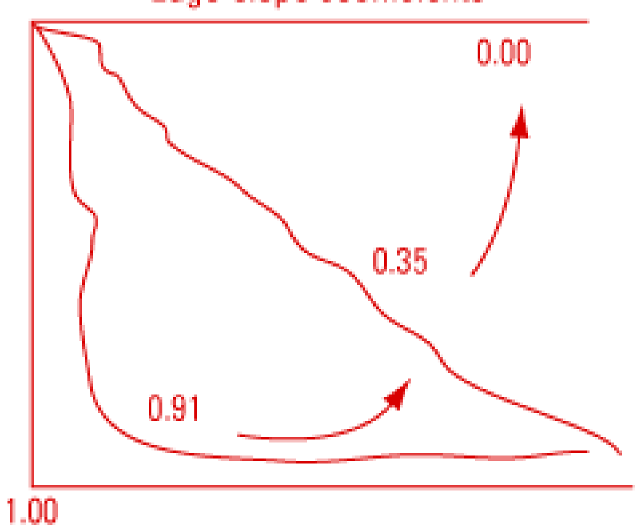

Figure 5.19. Edge-slope coefficient in the Transect 2.80+ configuration file. ADCP, acoustic Doppler current profiler.

```
PROCESSING
{
Average every (0.00 s)
Use Depth Sounder (NO)
MaxFileSize   (1200) — This value defaults to 1200 kilobytes. When the file size reaches
                       1200 kilobytes, it is saved and the file extension is incremented
                       by 001 and a new file is started.
External_formats   (N N N N N)   [ HDT HDG RDID RDIE ]
External_decode    (N N N N) [ heading pitch roll temp ]
Start_Shore_distance   (-1)  [ cm ]   These values will be added by the operator during
End_Shore_distance     (-1)  [ cm ]     transect if ...
Edge_distance_prompt   (YES) — ... THIS value is set to YES (prompts the operator for edge
}                                  values).
```

Figure 5.20. Transect 2.80+ directives in the processing section of the configuration file.

configuration file must be loaded before the operator moves to the scaling screen. In the DISCHARGE EXTRAPOLATION box, the “Prompt for Edge Shore Distances” should be set to YES with the spacebar. The “Edge Shore Coefficient” for the channel should be selected. If the “Edge Shore Coefficient” is unknown, TRANGLE should be selected.

Summary

The Transect software requires a companion configuration file for each measurement session. The configuration file contains instrument and recording setup data that enable the Transect software to properly measure the cross-section discharge and to store the resulting data. This configuration file can be created from within the Transect software or can be modified from a preexisting configuration file using a text editor. The configuration file should be checked before use with an American standard code for information interchange (ASCII) text editor to verify that the correct direct commands and recording parameters have been included and that unwanted commands are not present.

CHAPTER 6: DATA ACQUISITION

Operation of Transect Software

As described in chapter 5, Transect is a series of stand-alone software modules that are run from an executable menu program named Transect.exe. Transect.exe is an MS DOS-based computer program that can be run from an MS DOS prompt or from a batch file. There are several command line switches that can be used when running Transect, but we will discuss only the “/m” switch. The /m switch runs the Transect software in monochrome mode. It can be used when running Transect on a laptop with a monochrome liquid crystal display or on a laptop with a color screen if increased contrast is desired. For example, if the operator wishes to start Transect in monochrome mode, he would simply invoke Transect by typing TRANSECT /M at the command prompt. The default (color) mode is invoked by simply typing TRANSECT at the command prompt. Unlike unix, MS DOS commands can by typed in upper or lower case.

In chapter 5 we discussed the communication, calibration, and planning modules of the Transect software. In this chapter we will discuss the operation of the Acquire module.

Loading the Configuration File

During Transect initialization, the Transect software must obtain a valid configuration file. The proper configuration file can be loaded manually into the Transect software from any of the menus by pressing F3 and supplying a configuration file name (for example, by typing SACU.CFG). The Transect software stores the name of the last configuration file used in a small file called TRANSECT.PTR. TRANSECT.PTR may be edited and modified prior to entering the Transect software. For example, the TRANSECT.PTR file contains the following command: C:\SACU.CFG. When the Transect software starts, it will look for a file named SACU.CFG for its initial configuration. Any valid file path name can be entered into TRANSECT.PTR. For example, when TRANSECT.PTR is edited and C:\SACU.CFG is replaced with C:\BBTRAN26\SACU.CFG, the Transect program will find and load SACU.CFG from the C:\BBTRAN26 directory.

Starting the Transect Acquire Module

Entry into the Acquire menu (fig. 6.1) causes the Transect software to load a configuration file using the path name in the TRANSECT.PTR file. If a valid file name is not present in TRANSECT.PTR or if

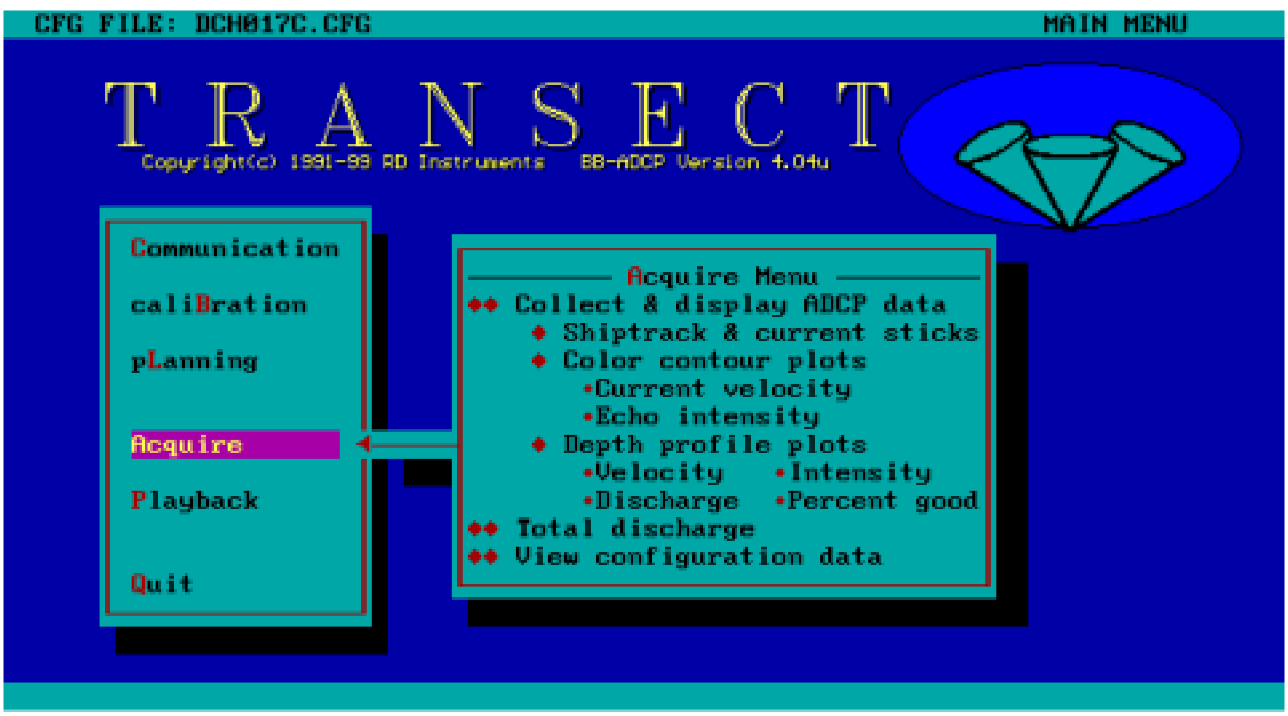

Figure 6.1. Transect software main menu. BB-ADCP, broad-band acoustic Doppler current profiler.

TRANSECT.PTR is not present, Transect will prompt the operator for a configuration file name. After loading the configuration file, Transect sends a “break” signal to the ADCP and waits a short time for a response. This is termed “waking up” the ADCP. If the ADCP does not wake up, usually it is because the operator has failed to turn on the power from the deck unit or that a communications or power cable has not been connected. If all attempts to communicate with the BB-ADCP from the Acquire menu meet with failure, the operator can do one of two things: exit the Transect software and try to establish communication with the ADCP using BBTALK or another terminal-emulator program, or enter the Transect software communication ADCP submenu and select auto connect. The Transect software will cycle through all combinations of baud rates and configuration combinations until it successfully establishes communications or it makes so many failed passes that the operator finally looses patience and calls for help. The BB-ADCP technical manual contains trouble-shooting procedures in cases of BB-ADCP failure or apparent faulty operation.

Once the ADCP is communicating properly, the introductory screen for the Acquire menu will appear on the monitor. This screen (fig. 6.2) contains helpful information on the setup and configuration of the ADCP:

•ADCP communication parameters;

•ADCP firmware parameters—firmware-release version, beam angle, operating frequency, coordinate system, operating mode, orientation system, and head configuration (pattern);

•Recording selections;

•ADCP operating variables: depth cell length, number of depth cells, pings per ensemble, time between pings, and blanking distance;

•Configuration file processing parameters.

The BB-ADCP operator should inspect the data for accuracy before continuing with the Transect software session.

Transect-Data Displays

The F10 or escape key then can be pressed to invoke the Transect software profile menu.

The Acquire menu provides many different ways to view ADCP data as they are being collected. Typically, most users will view incoming data using the Tabular display. Some of the available data displays are described below:

•Profiles of water velocity, echo intensity, and discharge cross product may be displayed (fig. 6.3).

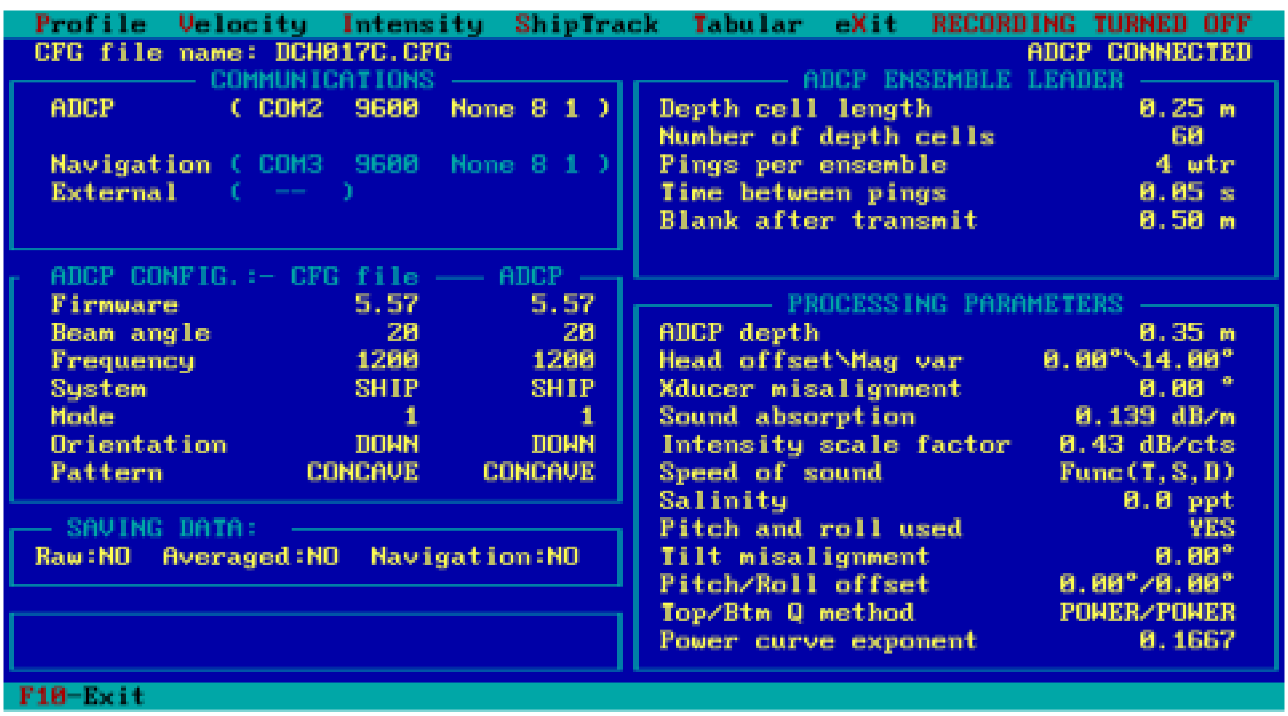

Figure 6.2. Transect software Acquire introductory screen. ADCP, acoustic Doppler current profiler.

•Color or monochrome plots of north velocity, east velocity, vertical velocity, error velocity, and velocity along a user set azimuth may be displayed (fig. 6.4).

•Backscattered intensities (fig. 6.5) also may be contour plotted. This can be useful for providing the operator with a relative indication of

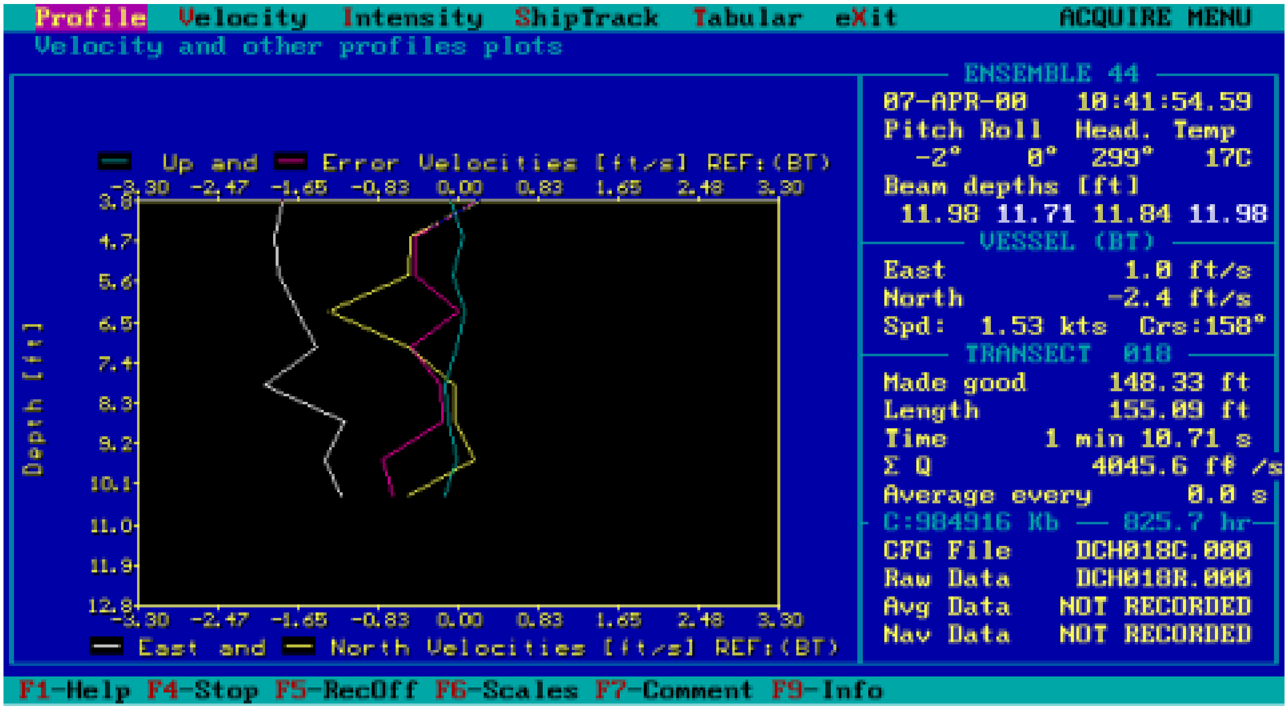

Figure 6.3. Transect software Acquire profile menu screen.

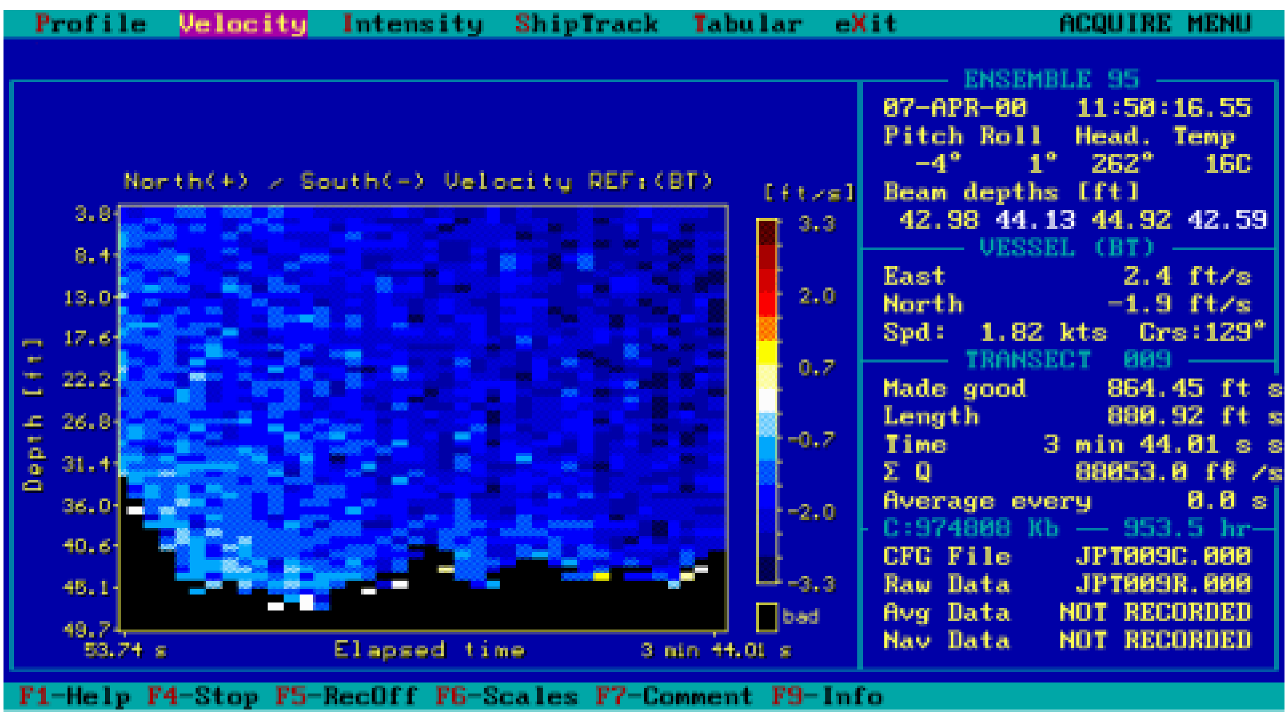

Figure 6.4. Transect software Acquire velocity contour plot screen.

suspended-sediment concentration in the measured cross section.

- The movement of the boat can be displayed in the so-called shiptrack plot (fig. 6.6). The operator also can display velocity vector “stick” plots at specified depths.
- Measured velocities, intensities, and correlations may be displayed in tabular form

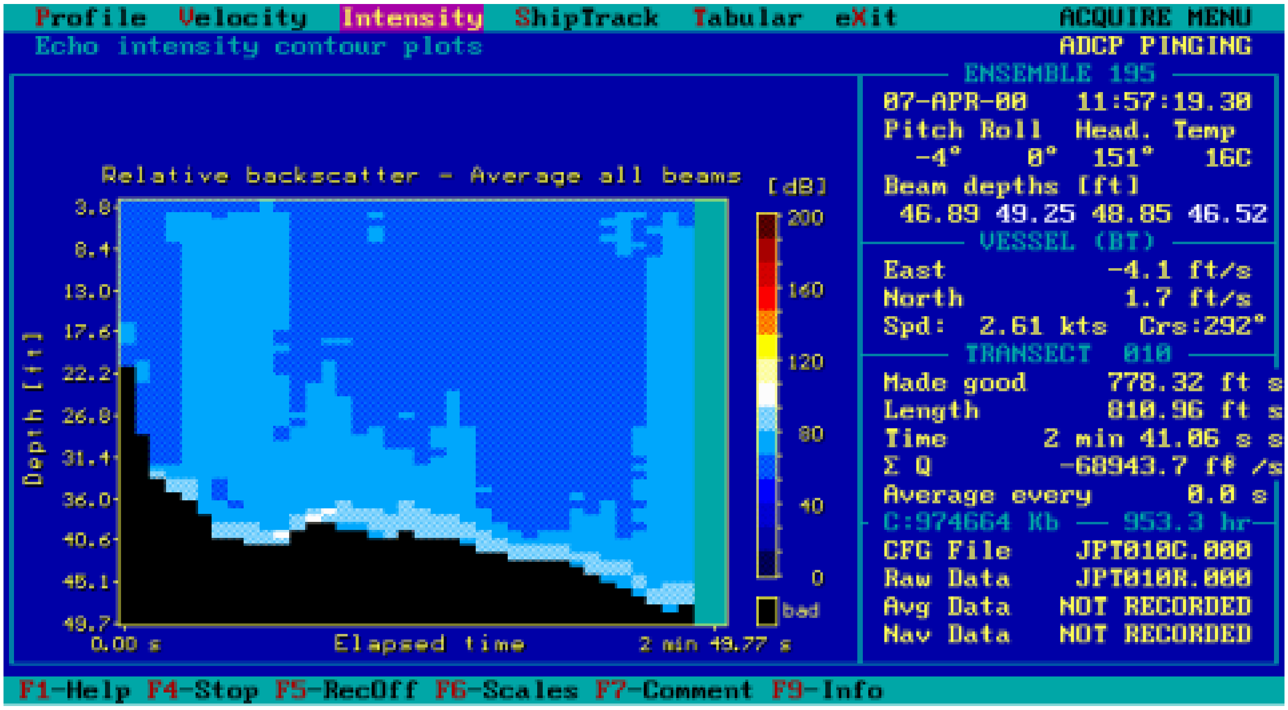

Figure 6.5. Transect software Acquire intensity contour plot. ADCP, acoustic Doppler current profiler.

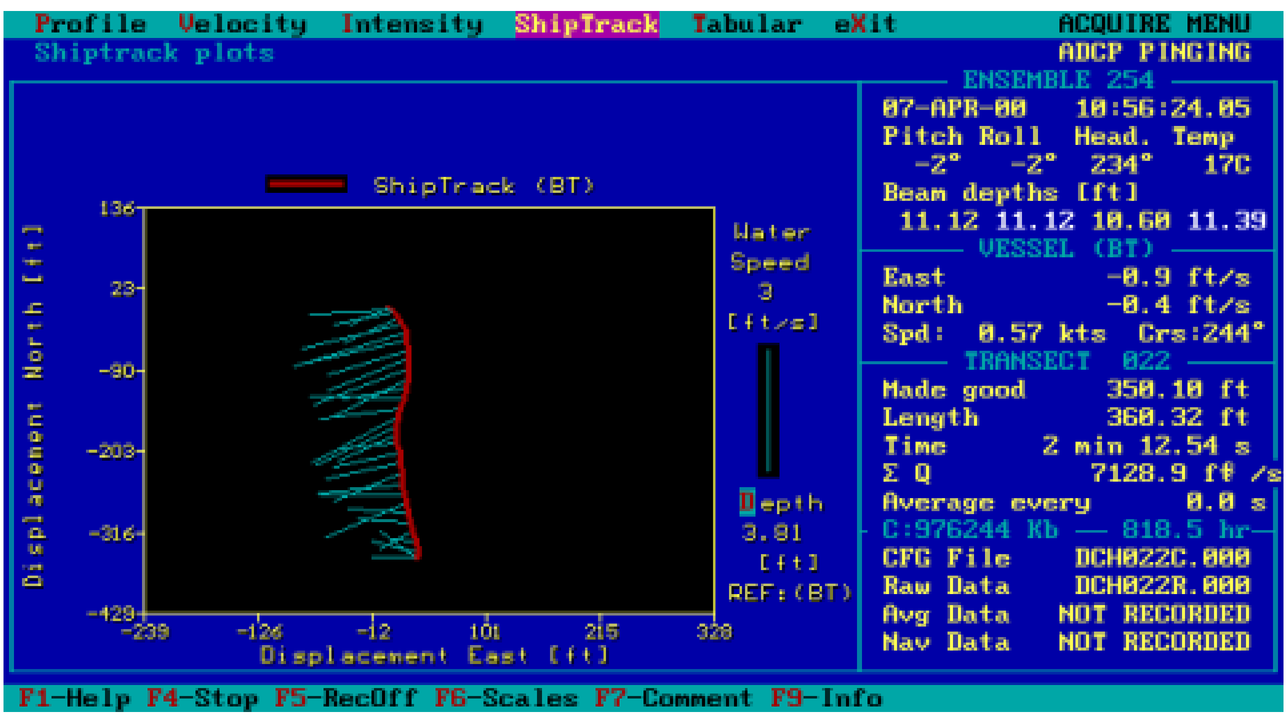

Figure 6.6. Transect software Acquire shiptrack plot. ADCP, acoustic Doppler current profiler.

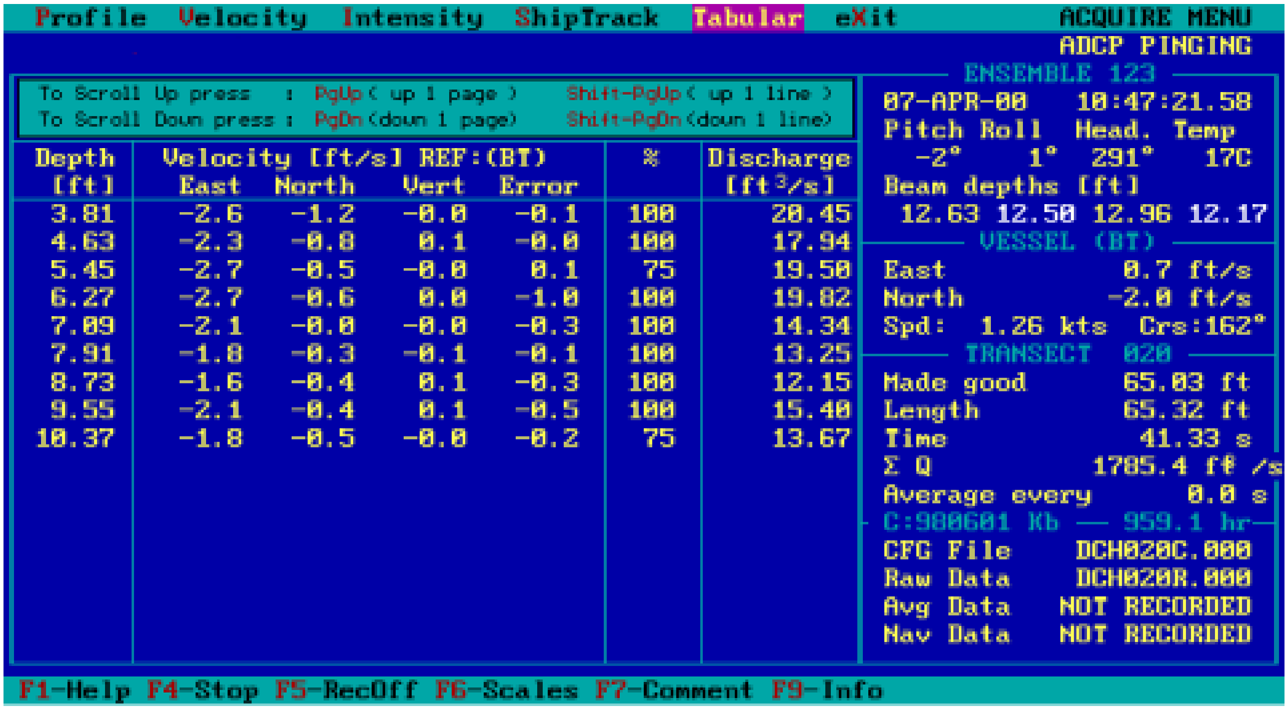

Figure 6.7. Transect software Acquire tabular display screen. ADCP, acoustic Doppler current profiler.

(fig. 6.7). The tabular screen is the most useful of the many displays available because of the information it imparts. The operator can tell quickly if error velocities are high, or if beam measurements or bottom tracking are bad, and scale factors need not be preset.

Transect-Data Recording

Data are recorded under the file name given in the RECORDING section (figs. 5.11 or 5.16) of the configuration file. Recording of the data to a data file is controlled by toggling the F5 key. When the Transect software is instructed to start recording (by toggling the F5 key), the discharge-measurement registers (but not the ensemble counter) are set to zero. The F4 key, on the other hand, wakes up the ADCP, starts the ADCP pinging, and resets the discharge-measurement registers and ensemble counter. Chapter 7 presents a detailed description of the use of the F4 and F5 keys.

Summary

Transect software data acquisition is invoked using the Acquire menu. The Transect software always loads the last used configuration file. There are two ways to load a new configuration file. The first is to edit the TRANSECT.PTR file and insert the path name of the configuration file before starting the Transect software. The second is to use the F3 key when starting the Transect software. The software then will prompt the operator for a configuration file name.

Actuating the F4 function key starts the data collection by the acoustic Doppler current profiler (ADCP). Recording can be toggled on and off with the F5 key.

Data displays during data acquisition can be selected by the operator. The tabular view is one of the more useful displays available during data collection. Some operators prefer to collect data while displaying profile plots of velocity magnitude and direction.

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